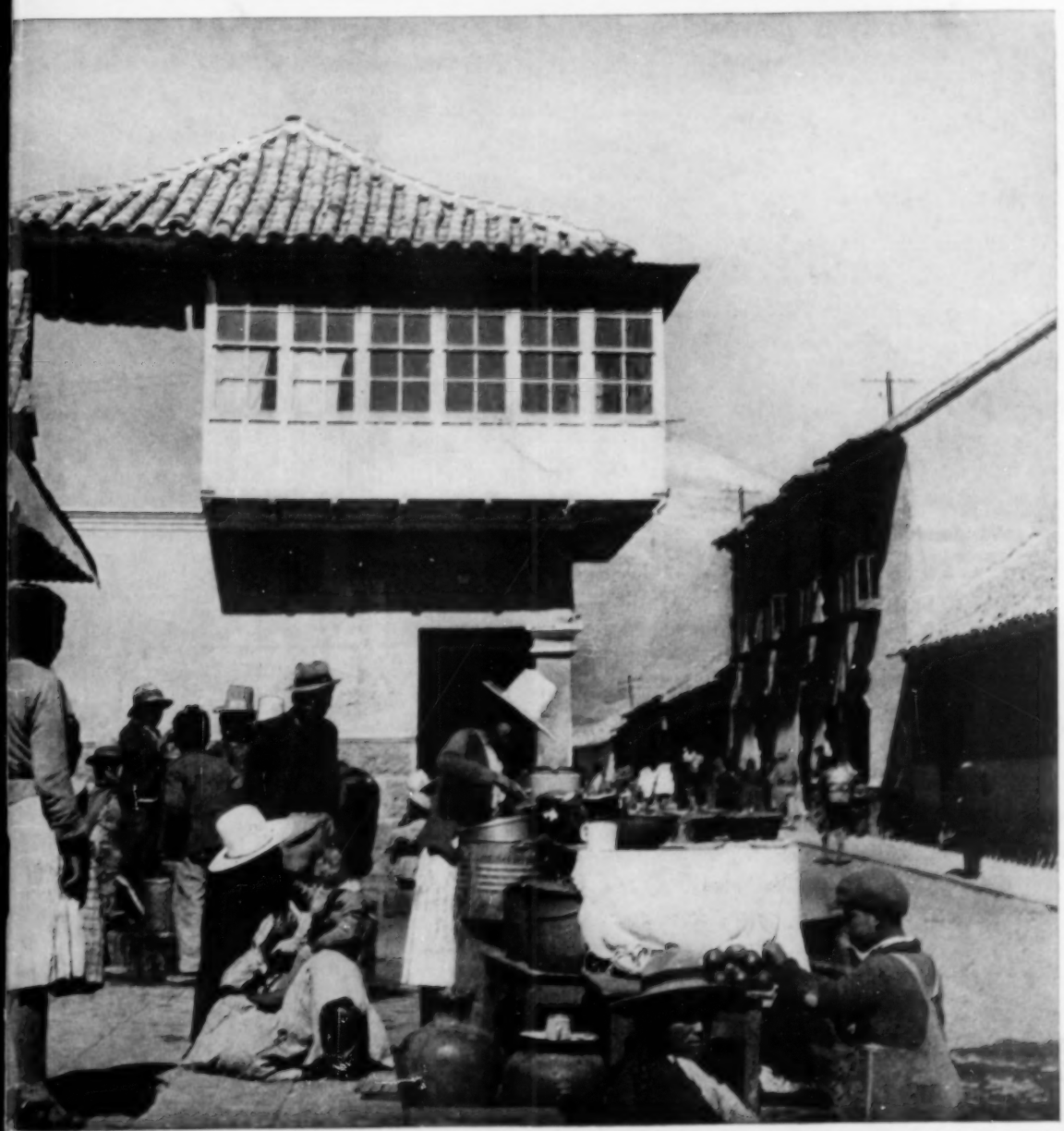
Compressed Air Magazine

DECEMBER 1943

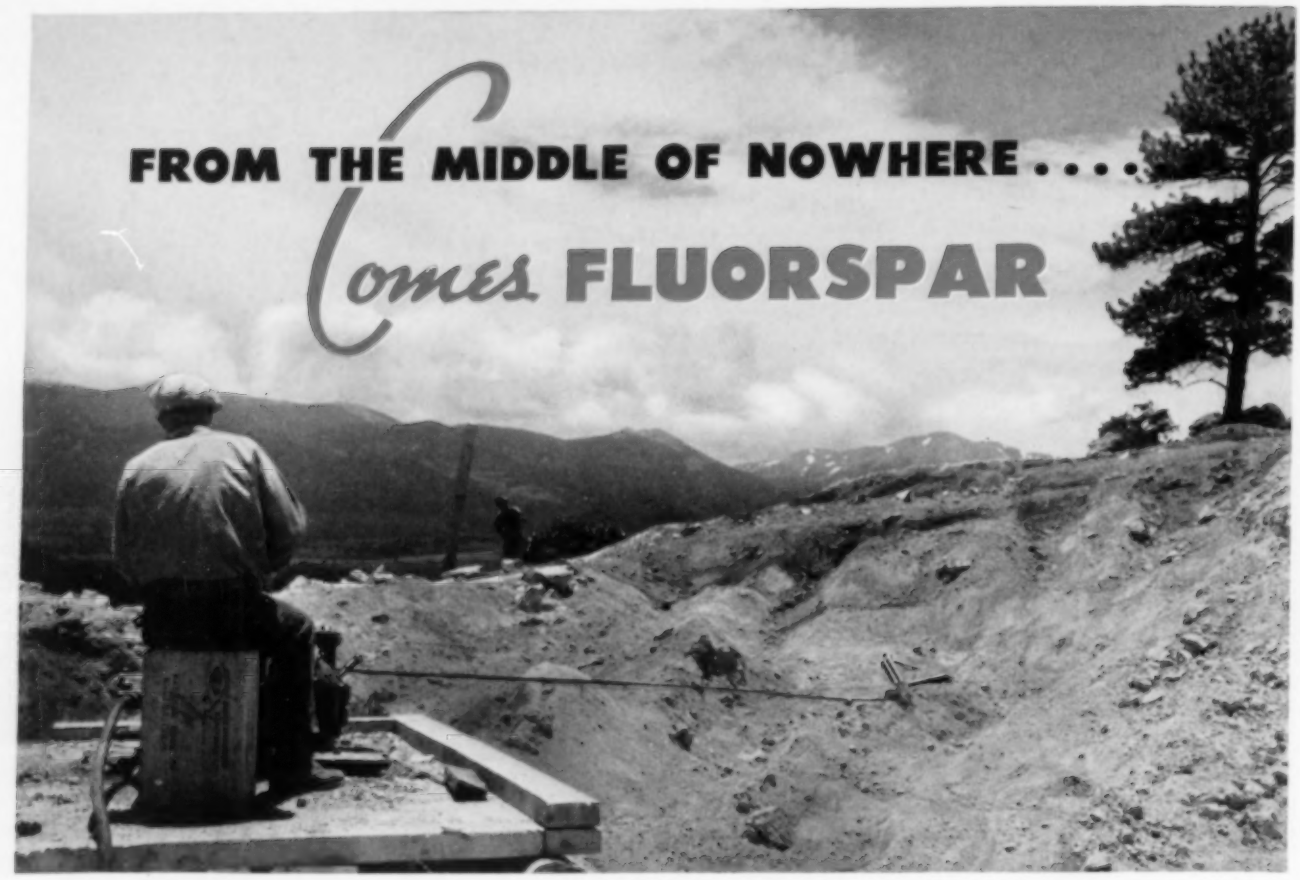


ICE CREAM
MADE TO ORDER

A purveyor of frozen sweets in a Bolivian mining town

VOLUME 48 • NUMBER 12

NEW YORK • LONDON

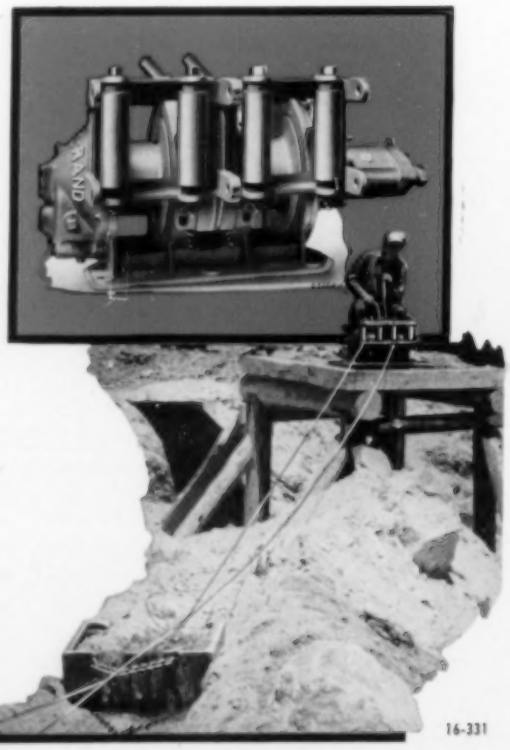


The mining of fluorspar ore from a mountain "in the middle of nowhere" is no easy task. The view above shows a fluorspar deposit that is in loose formation, not conforming to conventional vein form.

The remoteness of this property and the method of mining called for a compact, lightweight, rugged, air-powered scraper hoist to gather, transport and load the ore. That is why the Size A4NN-OJ was selected. It is a 250 lb. compressed air-driven scraper unit...a mechanical loader that *two men can carry*. This reliable machine handles all of the ore mined, transporting it from the open cuts to the loading chute under the timber platform.

With a rated rope pull of 850 lb. at 125 ft. per min., the "Lightweight" A4NN-OJ is widely used for scraping jobs in thin narrow veins or stopes, irregular veins, cross-cuts, for spreading waste, development work, sideswiping, station cutting, and many other materials handling jobs.

You will want to know more about this hoist and also our complete line that includes a size for every kind of mucking work. Send for a copy of our Slusher Hoist Catalog, Form 2379-B.



Ingersoll-Rand

11 Broadway, New York 4, N. Y.

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS
OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

16-331

More than a "Separator"

PROTECTOMOTOR PIPE LINE FILTER DELIVERS *Clean* AS WELL AS *Dry* AIR

Rust, Pipe Scale, Dirt and Dust removed in addition to Water and Oil

Repeat orders from hundreds of leading American concerns prove that Protectomotor Pipe Line Filters save money, speed production. Easy and quick to install, Protectomotors have often saved their entire cost in a single month.

Find out how in your operation Protectomotors will increase output, help win the war.

WRITE FOR CATALOG

DOLLINGER CORPORATION
(Formerly STAYNEW FILTER CORP.)
7 CENTRE PK. ROCHESTER 4, N. Y.

Air Filter Headquarters

FILTERS FOR PIPE LINE, ENGINE INTAKE AND BUILDING VENTILATION

Temperature Changes Mean Trouble in Unprotected Air Lines

Moisture in compressed air is condensed as the air passes through cold sections of pipe. Unless removed, this water washes out lubrication from air-powered tools, freezes upon expansion in these tools, and causes loss of power or stoppage due to clogging of ports; causes delays and waste at other points of compressed air usage. Dollinger Pipe Line Filters (Protectomotors), installed as near point of use as possible, remove condensed water and prevent these troubles.

Model CPH

Positive Action ★ Exclusive Construction

As air strikes Baffle (2) most water, oil and heavier particles are thrown to sides of Container (1), draining to bottom where excess is drawn off thru Drain Cock (5). Passage of all wet or dry matter is positively prevented by exclusive Feltex dry-type filtering medium in patented Radial Fin Insert (4) in louvred housing (3). Only clean, dry air is delivered.

STAYNEW PROTECTOMOTOR FILTERS

YOU NEED PROTECTOMOTOR MORE THAN EVER IN WINTER

Now it can be told how AMERICAN HAMMERED developed Chrome PISTON RINGS

World's largest porous chromium plating plant.

This is the story *behind* a story . . . the first public disclosure of an important new process that helped write hundreds of tales of Allied air supremacy.

Now the Axis has heard it the hard way, our story is a military secret no longer . . . and American Hammered can tell you the facts about its revolutionary new process for armor-plating piston rings. A story that holds *double* promise for America, because the vital contribution these rings are making to victory forecasts important service in the post-war industrial and transportation fields.

By the patented PORUS-KROME* process—perfected for piston rings by American Hammered before Pearl Harbor—the outer ring surface is electroplated with harder-than-steel, porous chromium plating. Oil clings to this new surface of special chrome "with pores,"—keeping the cylinder walls lubricated. Even during 700 m.p.h. fighter-plane dives . . . even when marine engines roar unchecked in sea battle maneuverings . . . this special surface of chrome "with pores" adds new power to high speeds, and hours to operating life. In desert flying, this new, porous chrome guards cylinder walls against the destructive action of sand and dust found at altitudes up to twenty-thousand feet!

To get these rings into every Army and Navy engine without delay, this organization constructed and is operating the largest porous chromium plating plant in the world.

This great development in engine performance has impressive post-war significance for all American Hammered customers.

KOPPERS COMPANY

American Hammered Piston Ring Division

BALTIMORE, MARYLAND

* VAN DER HORST PROCESS

KOPPERS

THE INDUSTRY THAT SERVES ALL INDUSTRY

WE HAVE it if they ask for it . . . canned in special 1-ton containers by the Chemical Warfare Service of the Army Service Forces.

Compressors are as necessary in the handling of war gas as in the operation of rock drills and other air-driven industrial equipment. Whatever the service, Texaco keeps compressors on the job, performing at maximum efficiency.

Texaco Alcaid, Algol and *Ursa Oils* assure wide-opening, tight-closing valves, free piston rings, open ports, clean air lines, maximum service life between overhauls, fewer repairs and replacements.

A Texaco Lubrication Engineer is freely at your service through more than 2300 Texaco distributing points in the 48 States. The Texas Company, 135 E. 42nd St., New York 17, N. Y.

THEY PREFER TEXACO

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.

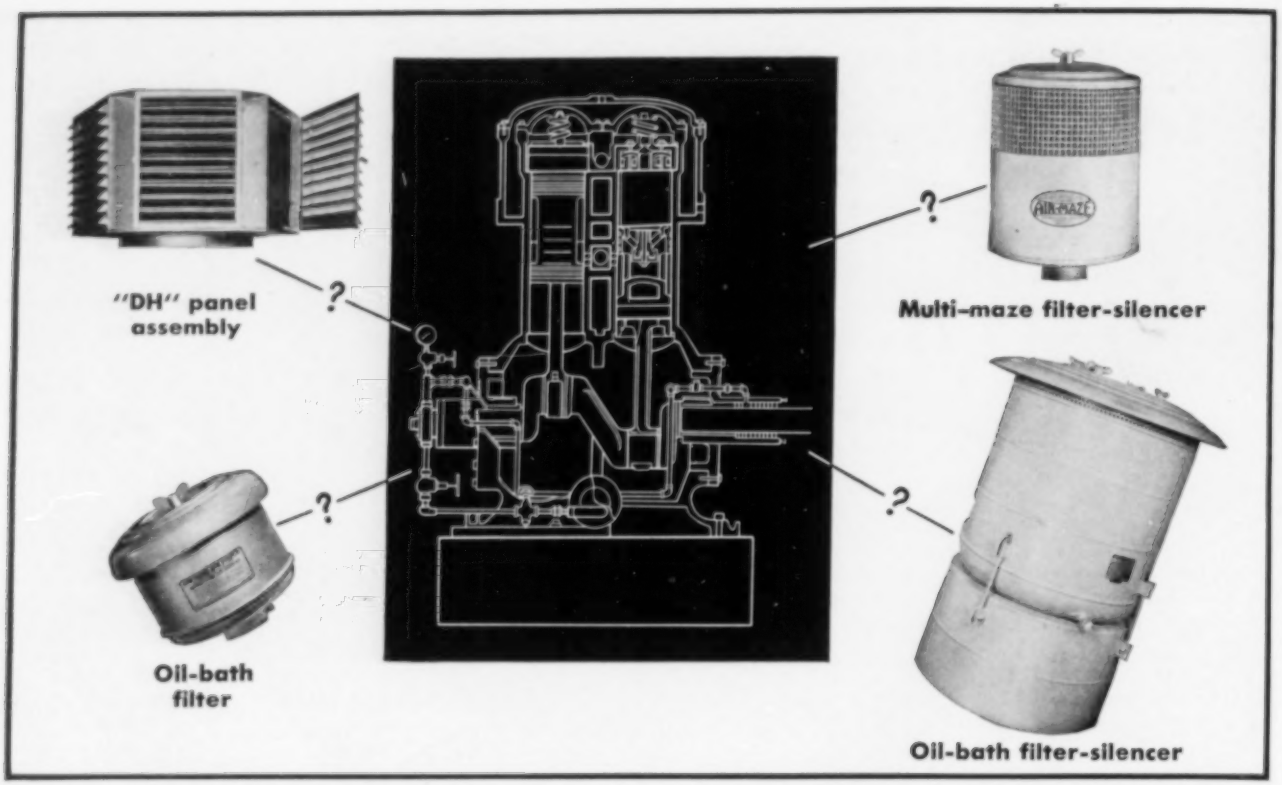
★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

TEXACO

TEXACO LUBRICANTS

FOR ALL AIR COMPRESSORS AND TOOLS

TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT — CBS ★ HELP WIN THE WAR BY RETURNING EMPTY DRUMS PROMPTLY



Who'll Pick the Filter for this Compressor?

We hope it's the man who knows two things: the compressor and the conditions under which it operates.

The harmful effects of dirty intake air are so well-known that experienced engineers insist on maximum filter efficiency.

To get it, they first select the general *type* of filter best suited to the particular dust conditions under which their compressors (and engines) operate. Frequency of servicing or replacement also has an important bearing on this selection.

All filters operate best at certain velocities, depending on their design. To keep air velocity within the range of a filter calls for accurate sizing.

With a complete line of more than 3,000 filters, Air-Maze engineers are in a position to recommend exactly the type and size to give utmost protection—with the minimum of maintenance, since Air-Maze filters are permanent, require no replacement.

IT'S EASY TO SIZE AIR FILTERS WITH THIS POCKET SLIDE RULE

Send for yours now

Everyone who specifies filters and filter-silencers for engine and compressor intakes can save time and insure accurate sizing with this handy calculator. While the supply lasts, Air-Maze will be glad to fill requests, without cost or obligation.

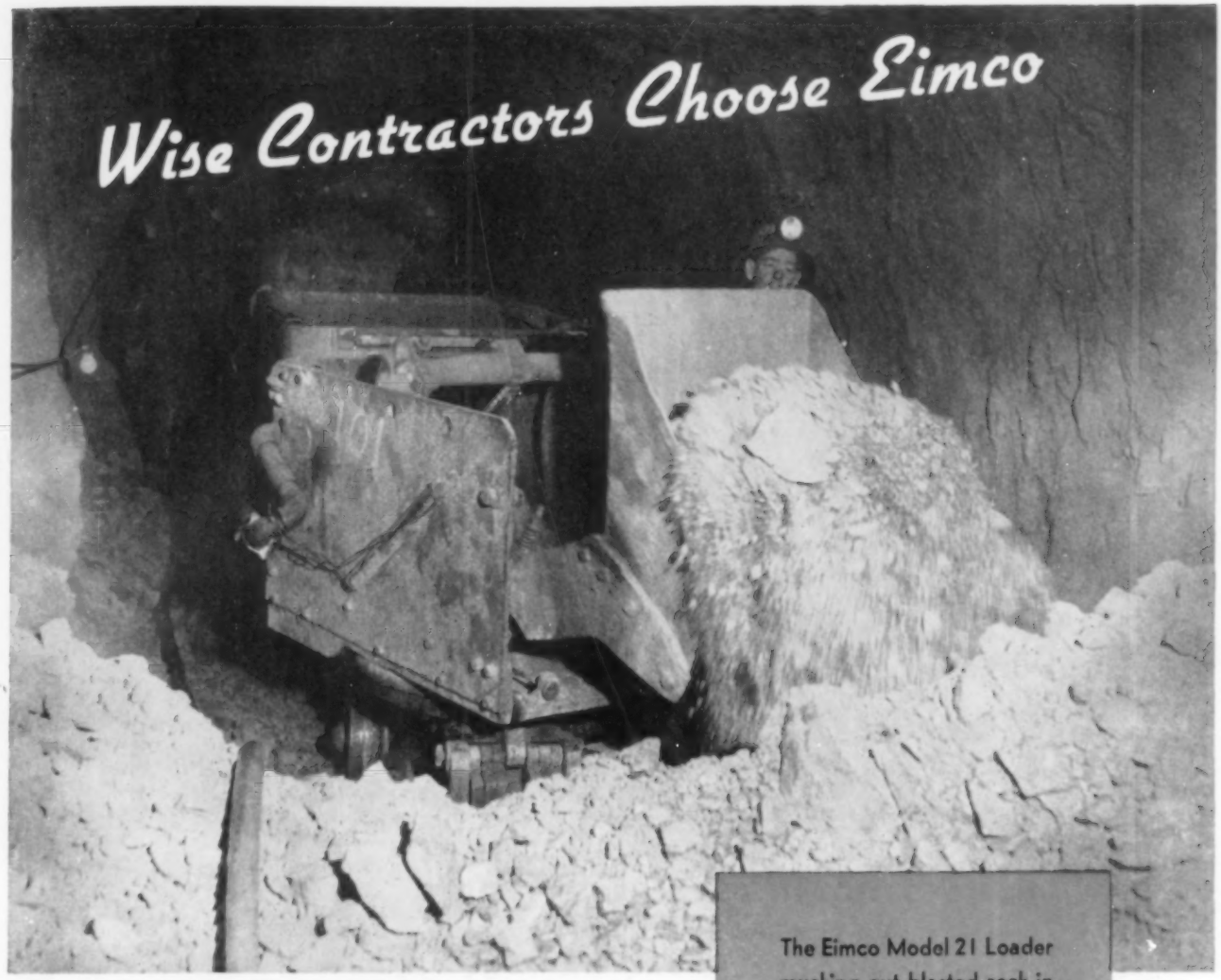
AIR-MAZE CORPORATION • *Engineers and Manufacturers* • **CLEVELAND 5, OHIO**

Representatives in Principal Cities • *In Canada:* Williams & Wilson, Ltd., Montreal, Toronto, Quebec, Windsor

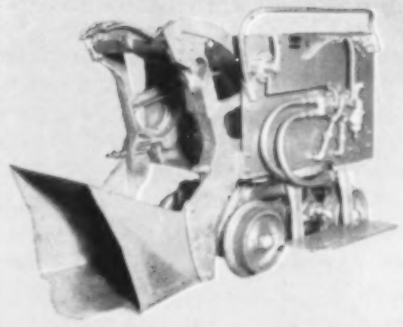
AIR-MAZE

SPECIALISTS IN AIR FILTRATION

Wise Contractors Choose Eimco



The Eimco Model 21 Loader mucking out blasted rock in the Treasury tunnel (size 7'x9'—loading time 1 hr.) The Treasury tunnel will open up thousands of tons of valuable ore in the famous Black Bear Mine.



Tunnel contractors prefer the Eimco Loader because it is built to take the roughest kind of work for twenty-four hours of every day. The Eimco Loader has a dependable record of performance in such outstanding jobs as the Elton, Carlton, Continental Divide, Treasury and numerous other tunnel jobs. The Eimco Loader guarantees low maintenance costs, ease of operation, freedom from gadgets. Contractors know that the Eimco Loader is familiar to hundreds of operators who can make footage records and when the job is done the Eimco Loader has paid for itself many times yet is still an asset, ready for the next job.

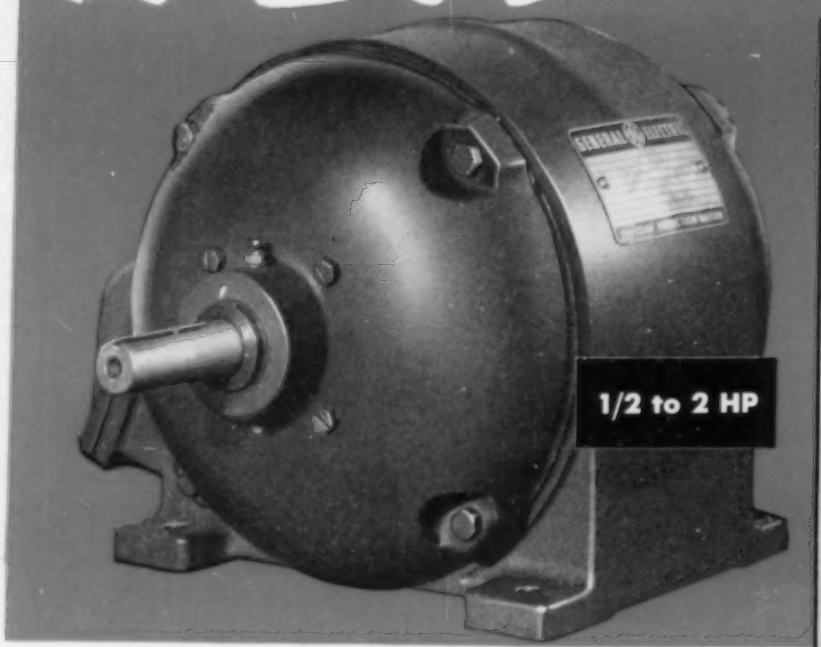
YES, WISE CONTRACTORS CHOOSE EIMCO!

EIMCO

THE EIMCO CORPORATION SALT LAKE CITY 8 UTAH
NEW YORK 120 BROADWAY SACRAMENTO 1217 7TH ST
CHICAGO 111 W. WASHINGTON ST EL PASO MILLS BUILDING

NEW TOTALLY ENCLOSED TRI-CLAD MOTOR

REG. U.S. PAT. OFF.



FULLY ARMORED AGAINST THE ENTRY OF DESTRUCTIVE MATERIALS—RESISTANT TO CORROSION AND EXTERNAL DAMAGE

On this new member of the Tri-Clad motor family, end shields and frame are solid cast iron, smoothly contoured and tightly fitted. Ball bearings are protected by a rotating-labyrinth bearing seal—against damaging dusts or liquids. The leads are sealed in compound in a cast-iron pocket in the frame. Inside, the motor has all the extra-protection features of Tri-Clad open motors, such as Formex* wire.

An outstanding feature of these new motors is that their mounting dimensions are interchangeable with those of open motors of like rating.

For complete information on the totally enclosed Tri-Clad, see your G-E representative, or write to General Electric Co., Schenectady, N. Y.

*Reg. U.S. Pat. Office

FRAME SIZES

Hp	Rpm	Poly-phase	Single-phase
1/2	900	204	
3/4	1200	203	204
3/4	900	224	
1	1800	203	203
1	1200	204	
1	900	225	
1 1/2	3600	203	203
1 1/2	1800	204	204
1 1/2	1200	224	
2	3600	204	204
2	1800	224	

FOR "CRUEL" SERVICE CONDITIONS LIKE THESE

(Meeting requirements of WPB Motor Conservation Order L-221)

DESTRUCTIVE DUSTS*

Where rock dust, metal filings, powdered chemicals, or other finely divided materials are present in destructive quantities.

CORROSIVE FUMES*

Where motors are exposed to corrosive acids and alkalies in liquid or vapor form, such as on mixers in chemical pilot plants.

GUMMY, VISCOUS MATERIALS

In working with paints, oils, syrups, and other materials which might "gum up" the interior of an open motor.

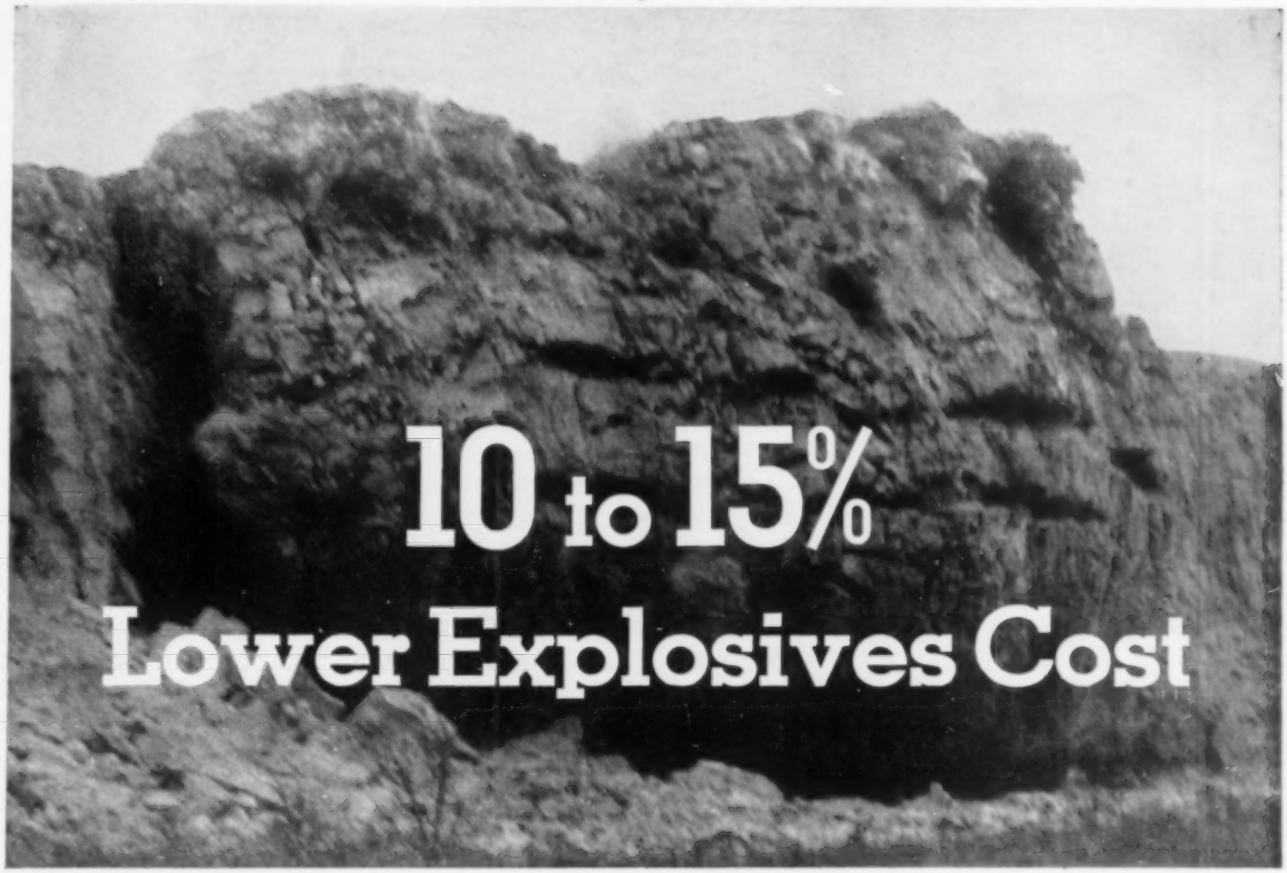
SUPERSATURATED ATMOSPHERES

Where motors must operate without fail in areas filled with steam, water vapor, oil droplets. Also out of doors in humid, stormy climates.

* In addition to this *standard* totally enclosed Tri-Clad motor, G. E. can furnish *explosion-proof* types, tested and listed by Underwriters' Laboratories, Inc., for (1) hazardous dusts, such as magnesium dust, coal dust, grain dust, (2) hazardous fumes, such as gasoline.

GENERAL ELECTRIC

760-214-8050



HERCOMITES*

The high weight strength and high cartridge count of the Hercomite explosives make them unusually economical. In comparison with the more conventional materials of this class, the Hercomites offer a 10% to 15% reduction in explosives costs. Hercomites are available in six different grades. They are especially suited for quarry work and for many underground operations.

GELAMITES*

The water resistance and plasticity of Hercules Gelamites permit their use under many water conditions which formerly demanded the more expensive gelatin explosives. Savings of 10% to 15% are realized when Gelamite 1 replaces 60% gelatin extra and Gelamite 2 replaces 40% and 50% gelatin extra. Like the Hercomites, they are especially suited for quarry work and for many underground operations.

*Reg. U. S. Pat. Off. by Hercules Powder Company

A-98

HERCULES EXPLOSIVES

HERCULES POWDER COMPANY
INCORPORATED

932 KING STREET, WILMINGTON 99, DELAWARE

No other industry rivals metal mining in the essentiality of its products for warfare, nor can any other industry make its full contribution to victory without these products. All the implements and instruments of modern warfare call for metals in ever increasing quantities—and our mines today are setting new production records.

Increased output means added wear and tear on machinery, more repair parts, new equipment—the responsibility of the equipment manufacturer is no less than that of the mine operator in the constant drive to produce more metals.

Today, more than ever before, it is essential that the supplier and operator work together. Only by careful study of each other's problems, by coordinated planning, by a united effort can the common objective be achieved. Contact our engineering service division nearest you. They will gladly help you with your problems.

Ingersoll-Rand

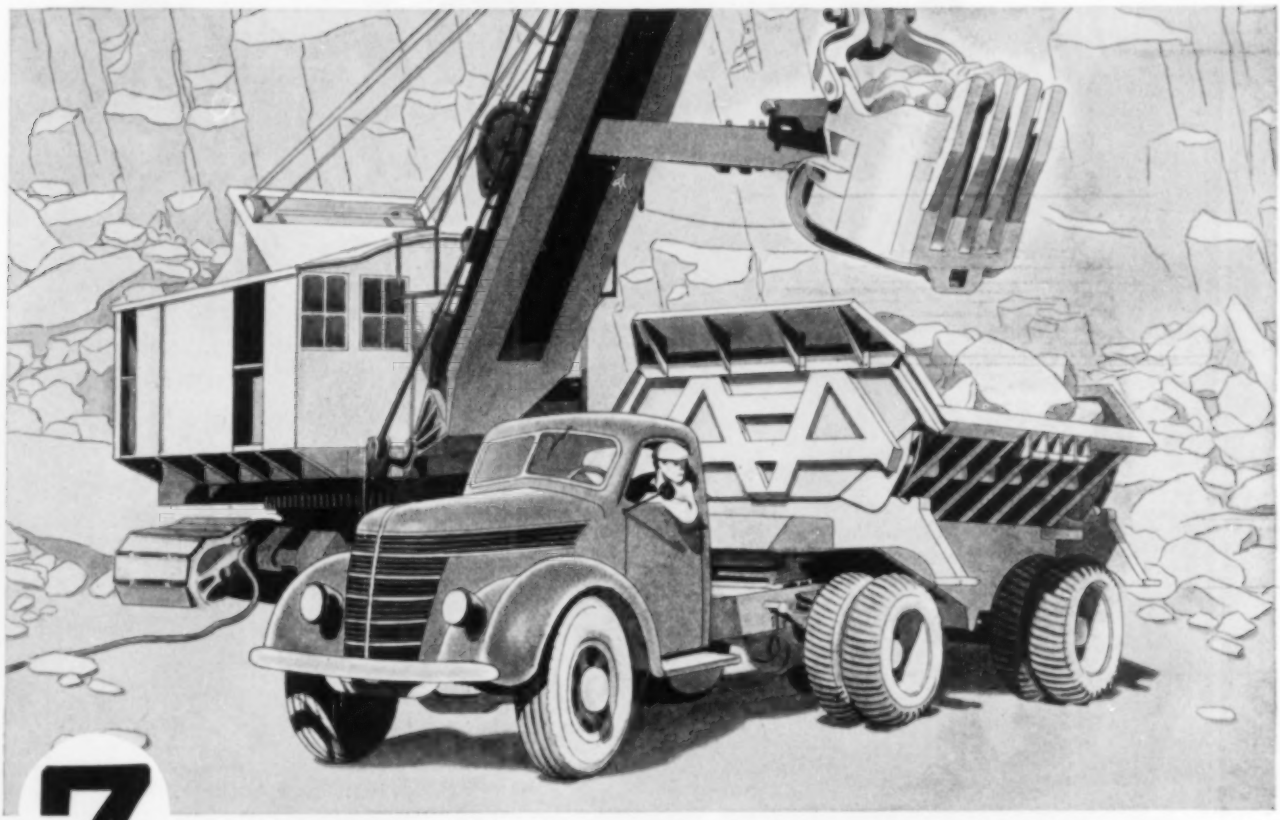
11 BROADWAY, NEW YORK 4, N. Y.

5-366

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

ACHIEVEMENT

—measured in millions of tons!



7 YEARS AGO a crushed-stone producer asked us to build the first semi-trailer for quarry haulage The idea was new, untried, challenging!

EASTON engineers, experienced through many years of pioneering in all phases of track and trackless quarry haulage, were alert to the possibilities of this new idea. Through the semi-trailer they foresaw the application of low-cost truck units to heavy duty quarry service, with the consequent saving in tires, fuel and manpower. They foresaw the value of continuous shovel and crusher operation made possible through a steady flow of material. They foresaw the amazing new low costs per ton of rock hauled.

The first EASTON Semi-Trailer, of approximately 15-tons capacity, fulfilled all expectation. Our engineers continued to work on the patented basic design. Shock-proof dumping was made possible by means of stabilizer feet made to rest on the crusher-hopper wall as the body discharged its load. Thus the tractor chassis was relieved of the shock and strain of dumping. Designs were completed for units ranging from 10 to 25 tons capacity. Dumping was accomplished by the EASTON automatic, fast-action, overhead hoist at a fixed point. Later developments extended the line of units to 30 to 40 tons capacity using the EASTON eight-tired, full-floating, tandem-axle running gear.

OVER 30 MILLION TONS A YEAR

Now, only seven years after the first unit was built, the record of EASTON Semi-Trailers in quarry service stands unchallenged for high tonnage and low cost. Today, as your watch ticks off each second, a ton of raw material is dumped from an EASTON Semi-Trailer into a crusher-hopper. Unknown seven years ago, these big modern containers are now hauling a total combined annual payload estimated at over 30 million tons a year!

Today it is important to remember that many gallons of precious fuel, many man hours and many miles of tire service are being saved where EASTON Semi-Trailers (Trackless Mine Cars) were installed to replace more costly equipment.

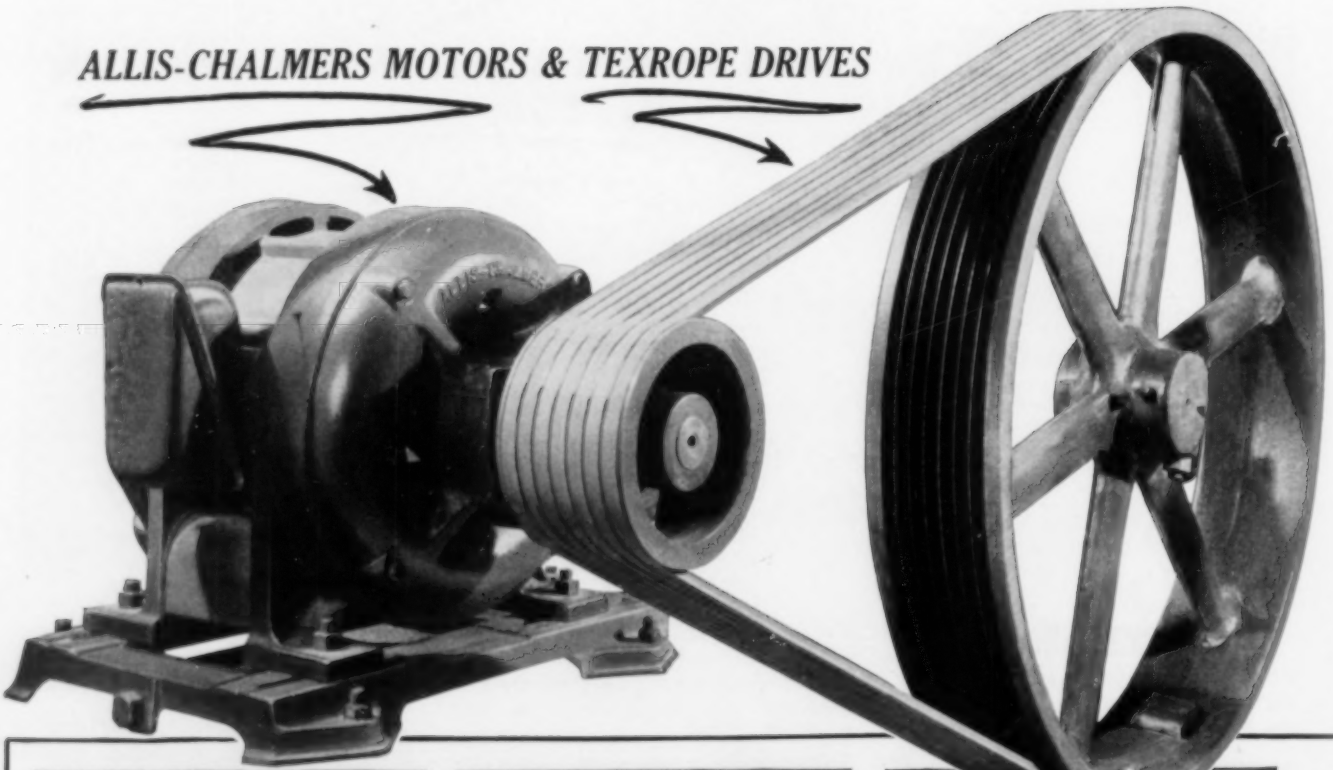
Certainly we are proud of our record of achievement. Yet, now, when wartime restrictions have reduced equipment orders to a minimum, we cannot rest on past accomplishments alone. To help in the conservation of useful equipment EASTON Engineers are cooperating with tractor and tire manufacturers in offering assistance to quarry operators.

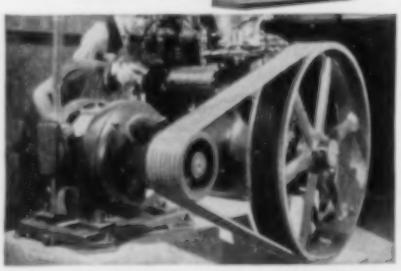
For bigger payloads with less fuel, less rubber, less manpower "keep moving with EASTON". Write to Engineering Counsel, Easton Car & Construction Company, Easton, Pa. B-1010

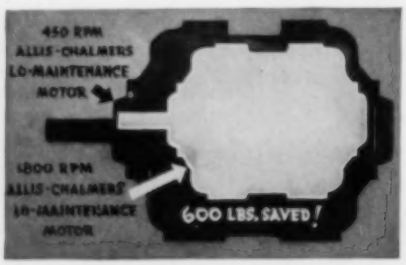
EASTON
INDUSTRIAL CARS
TRUCK BODIES · TRAILERS
ELECTRIC LIFT TRUCKS

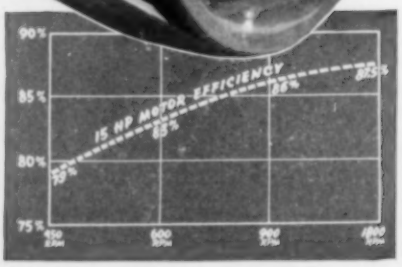
Here's the Team New Power

ALLIS-CHALMERS MOTORS & TEXROPE DRIVES









1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*

2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!

3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

WE WORK FOR VICTORY — WE PLAN FOR PEACE

ALLIS-

to Solve These Problems!

1. HOW TO DRIVE LOW SPEED MACHINERY WITH HIGH SPEED MOTORS? Allis-Chalmers Texrope Drives can "gear down" motor speeds over a range of 7 to 1. They're compact, highly efficient, protect your equipment by absorbing shock.

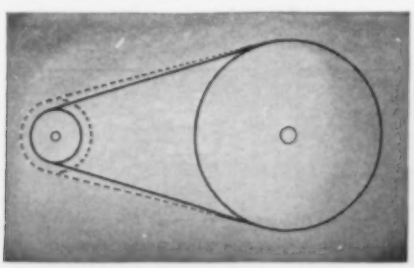
2. HOW TO DRIVE A MACHINE AT DIFFERENT RATES WITH A SINGLE SPEED MOTOR? Texrope Adjustable-Speed Drives give you infinite speed range up to 375%. And in Allis-Chalmers' full line of Texrope Drive equipment you'll find the *right* range for your machines . . . thus avoid paying extra for more speed than you need.

NOW THAT low-speed and multi-speed motors are sharply restricted, get the *flexibility* you need by teaming up available types of Allis-Chalmers Lo-Maintenance Motors with Texrope Drives.

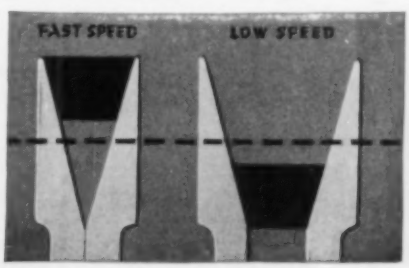
As America's only builder of *both* motors and V-belt drives, Allis-Chalmers has long studied and advocated their use in proper combination. Today, you benefit from Allis-Chalmers pioneering when you ask for—and get—the *right* combination of Lo-Maintenance Motor and Texrope Drive.

Call on any A-C district office or write to ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS.

A1647



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.



5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!

6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

CHALMERS

LO-MAINTENANCE MOTORS
TEXROPE DRIVES

WATCH Your Lubrication!

Your present excavating equipment will probably have to last for the duration. Under pressure for more and more output in its vital service on the production front, it is operating at top capacity, — very likely three shifts per day.

Good lubrication care, more than anything else, is the most effective maintenance insurance you can obtain. Proper lubrication will extend the life of your excavator, it will avoid breakdowns, will reduce cost of operation and increase output by reducing delays.

To keep your equipment in fighting condition, do these things:

Lubricate each part regularly and thoroughly as prescribed by your manufacturer's operating instructions.

Use the **right amount** of lubricant. Too much can sometimes be harmful.

Use the **right lubricant** as specified for each fitting and part. A good lubricant when applied in the wrong place may be more harmful than none at all.

Use only **good quality** lubricants. "Cheap" oils and greases are dangerous to the machine.

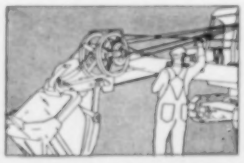
KEEP LUBRICANTS CLEAN

BUCYRUS ERIE

A good operator takes pride in his machine. He keeps it clean and trim and properly lubricated always. It pays off in smooth, continuous performance, maximum production, and long operating life.

HERE ARE A FEW SPECIAL POINTS TO WATCH

1. Ropes and drums should be lubricated regularly. Apply a thin layer often to avoid splatter in operation



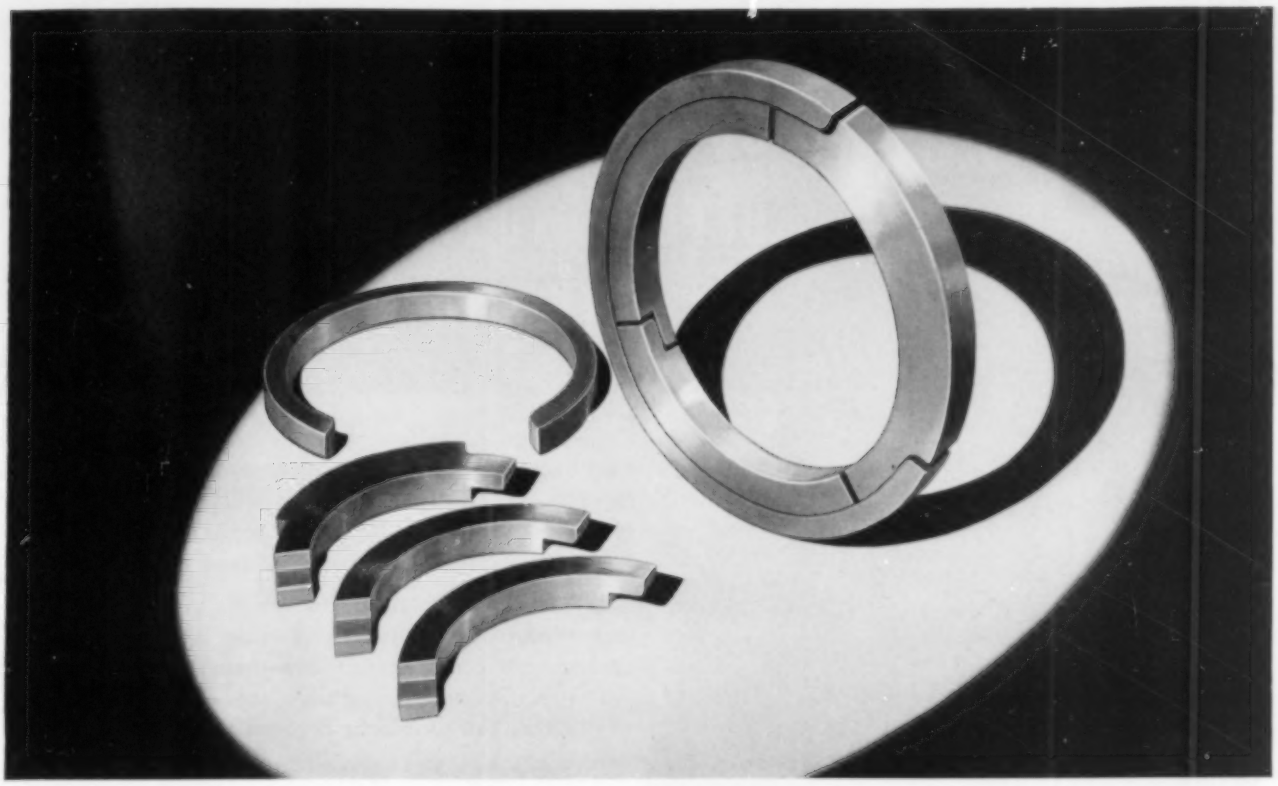
2. Be sure to lubricate the suspension ropes. They are likely to rust their strength away if you don't.

3. Lubricate cats even if machine is not propelled much, as normal digging reactions cause some wear

4. Keep the proper amount as well as the correct grade of oil in your gear enclosures at all times.

Bucyrus-Erie

SOUTH MILWAUKEE, WISCONSIN, U. S. A.



IMPROVED FIRE CHECKS

FOR DOUBLE-ACTING GAS ENGINE PACKINGS

IN a Double-Acting Gas or Diesel Engine packing, special packing rings are required that will withstand the impact of explosion and the intense heat of the burning gases. These rings are called Fire Checks.

COOK has engineered many style Fire Checks—each of unique construction to meet specific operating conditions. Of these Fire Checks, the styles used most widely in the oil and gas industries are Types RG, OG and K. Type OG is illustrated above. It is shown because it is typical of all three and most readily discloses the simplicity of construction. Note there are only four parts. Note the absence of any screws or rivets in the "lug" ring. Note also that the wearing segments have step-seal joints, thus enabling the use of only one ring per groove.

Type K differs from Type OG principally in the joint construction, having butt cut joints and is therefore used in pairs. But in either case the overall number of rings would be the same.

Fire Checks usually are made of COOK'S GRAPHITIC IRON, although Cookmet sometimes is used if a ring made of plastic bronze is indicated, in which case style RG is employed.

COOK'S improved Fire Checks have been time tested in the field before a general offering, as are all of COOK'S products. Today these improved Fire Checks are being used by leading operators in the natural gas industry everywhere.

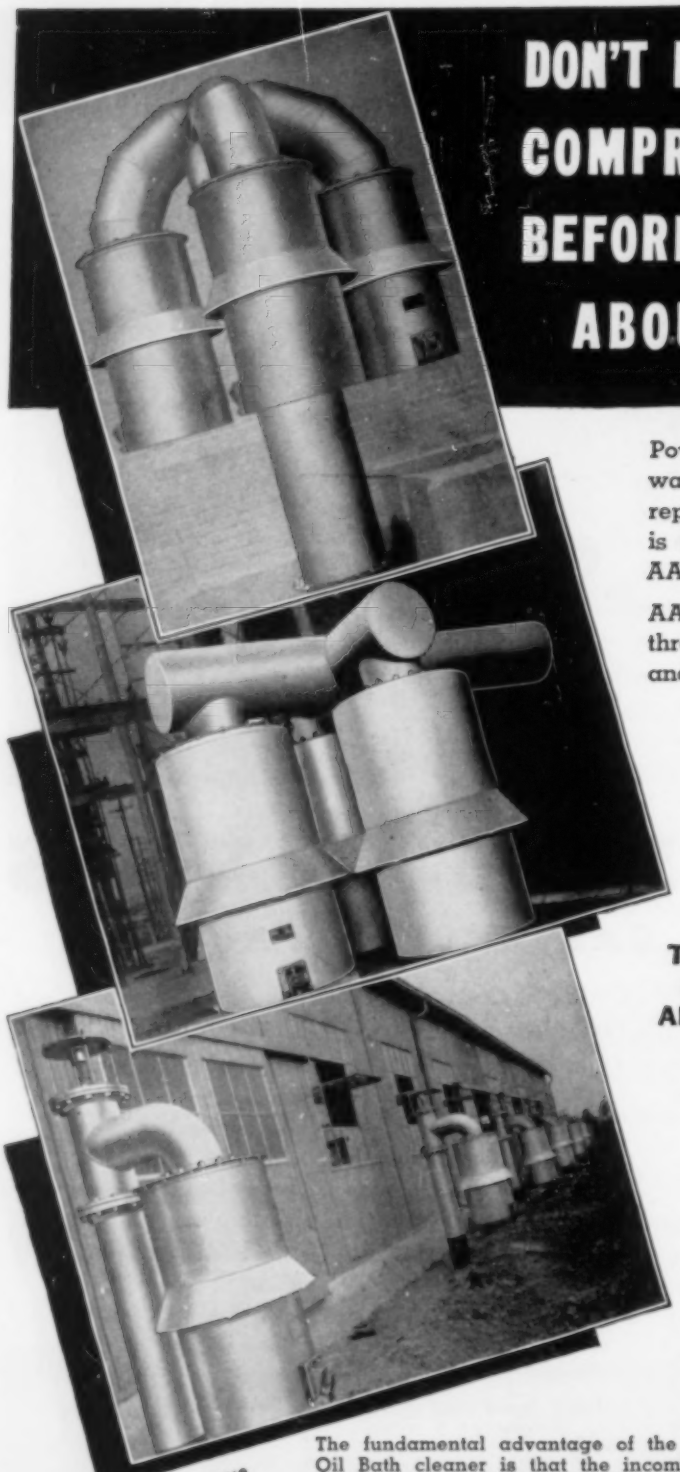
You, too, will find COOK'S Gas Engine Packings and COOK'S Compressor Packings a good investment. Our nearest office will give you prompt and efficient service. And when ordering new equipment, make sure you get the genuine by specifying COOK'S.

C. LEE COOK MANUFACTURING CO., Incorporated, Louisville, Kentucky. Branches and Representatives: Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, Montreal, New Orleans, New York, Portland, Ore., San Francisco, Seattle, Tulsa.

"Sealing Pressures Since 1888"

COOK'S METALLIC PACKINGS

DON'T MAKE YOUR ENGINES OR COMPRESSORS *Call Quits* BEFORE YOU DO SOMETHING ABOUT AIR CLEANERS!

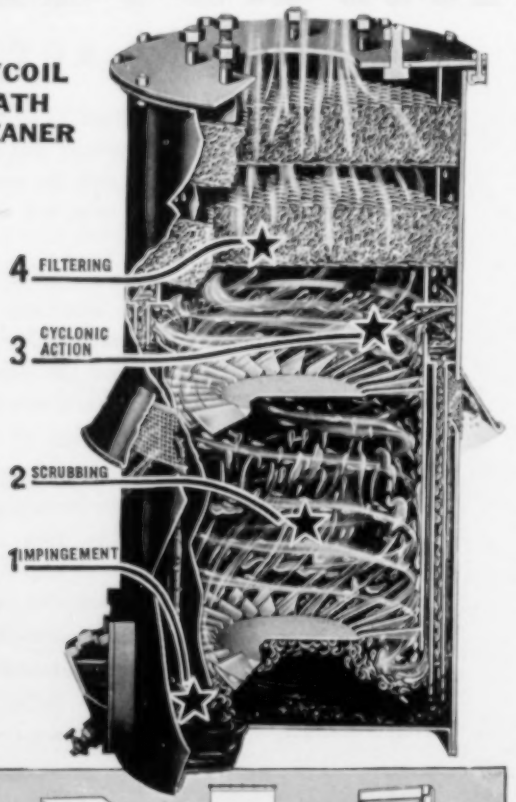


Power plants are too precious and important to the war effort today, to risk unnecessary shut downs for repairs—especially when such a small investment as is needed to equip engines and compressors with AAF air cleaners will eliminate most of the causes.

AAF air intake filters are in use on power equipment throughout the nation—protecting valves, cylinders and pistons against excessive wear due to dust and grit. Bulletins describing the entire line of AAF filters are available on request.

Shown on this page are photographs of several Cycoil installations. This air cleaner is outstanding because of its unique 4-way cleaning principle described below. Ask for Bulletin No. 130D.

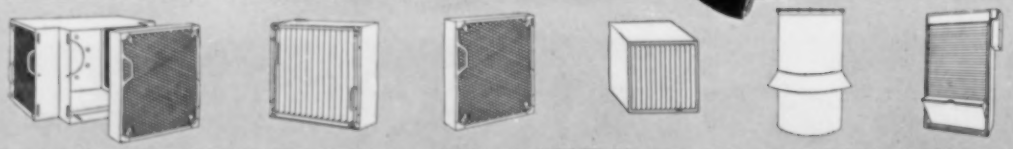
THE CYCOIL OIL BATH AIR CLEANER



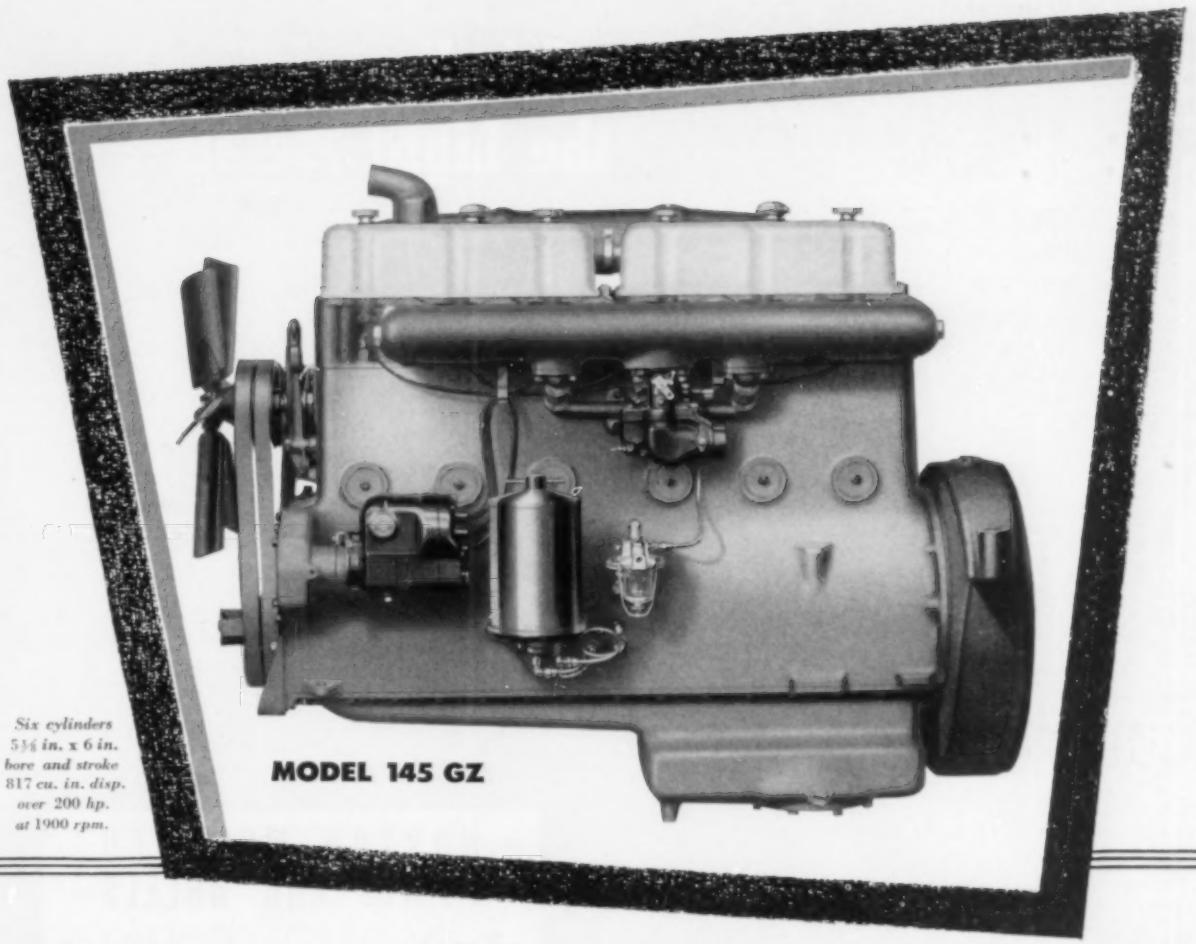
The fundamental advantage of the Cycoil Oil Bath cleaner is that the incoming air stream picks up an unusually large quantity of oil which is thoroughly mixed with the air (causing a scrubbing or precleaning action), and then thrown out by centrifugal action before the air stream enters the filter cell. This results in reducing the dust load on the filter cell and insuring continued self-cleaning action.

AMERICAN AIR FILTER CO. INC.
402 Central Avenue, Louisville, Kentucky
In Canada: Darling Bros., Ltd., Montreal, P. Q.

AAF



AMERICAN AIR FILTERS for ENGINES and COMPRESSORS



Six cylinders 5⅛ in. x 6 in. bore and stroke 817 cu. in. disp. over 200 hp. at 1900 rpm.

WAUKESHA ENGINES

FOR: High-Speed Heavy-Duty Trucks and Busses • Tractors • Bulldozers • Fire-Fighters • Logging Equipment • Generating Plants • Centrifugal Pumps • Open Pit Mine Haulage • Oil Field Servicing and Exploration

Look over the list of jobs that this Waukesha Gas or Gasoline Engine will be ready to do for you, right after it finishes its wartime job in heavy ordnance equipment.

It's really rugged! Crankcase and cylinder frame are one unit—a deep sturdy casting of high strength alloy iron. The crankshaft is drop-forged steel, heat treated—with seven 3½-inch main bearings.

The cylinders are wet sleeves . . . made of Molychrome iron. They are easy to remove and easy to replace—for simpler, lower cost maintenance.

A submerged gear-type pump forces oil by full positive pressure to every gear shaft and bearing, while valve tappets and cylinder walls are drenched by oil mist.

A gear-driven centrifugal water pump delivers a large volume of water in directed paths. Large, clear passages around valve seats. Thermostatic by-pass system guards against over-cooling and assures a quick warm-up when engine is started. *Get Bulletin 1186 for dimensions and specifications.*

MORE POWER FOR VICTORY

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS., NEW YORK, TULSA, LOS ANGELES

For Grinding the Light Metals . . .

Photo Courtesy of Sperry Gyroscope Co.

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THERE are Norton Mounted Wheels and Points that have been especially developed for grinding aluminum and magnesium. They are made of hard, sharp Crystolon abrasive which is especially effective for grinding the non-ferrous metals. They are vitrified bonded and have a special filler in the pores. This filler provides a lubricating action and prevents the ductile chips from loading the wheel surface.

Catalog 43-CA lists the nearly 200 sizes and shapes of Norton Mounted Points and Wheels.

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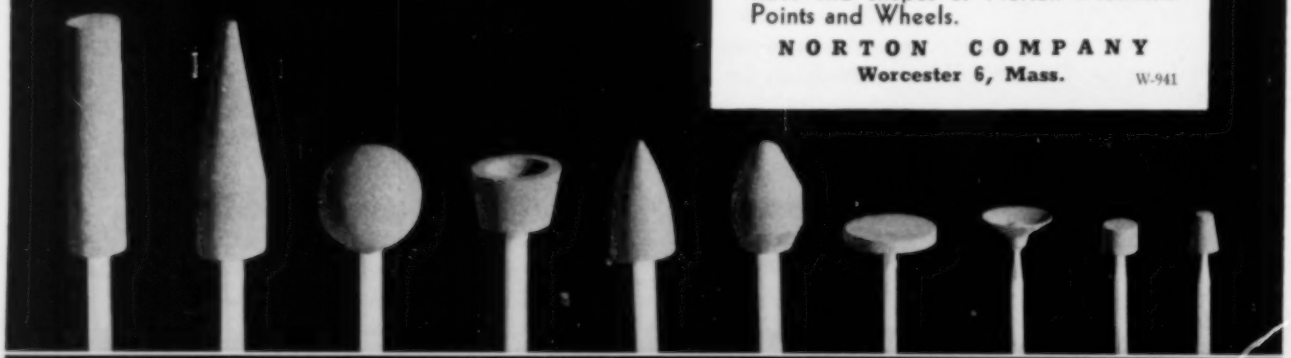

NORTON ABRASIVES

ON THE COVER

OUR cover picture was taken on one of the main streets of Potosi, 13,600-foot-high mining center of Bolivia that was once famed for its silver output and is now producing tin. The proprietress of the refreshment stand is making a portion of ice cream for a waiting customer. In front of her is a galvanized-iron tub containing cracked ice upon which a copper bowl rests; on the table are the ingredients and flavoring extracts. When a customer gives an order, the ingredients are put in the bowl and stirred, causing the bowl to revolve on its bed of ice. Sufficient cold is thus conducted through the copper to congeal the mixture in a few minutes.

IN THIS ISSUE

DURING the last World War the United States was an importer of cigarette paper; today it is an exporter. Just how this change in status has come about in so short a time is a story of accomplishment that concerns the use of a waste product. Our leading article tells the part one firm has played in establishing the industry.

STEEL tubing is one of our most-used engineering materials, its applications ranging from the construction of furniture to the equipping of vast manufacturing plants. Elmer T. Wible tells us how both seamless and welded tubing is produced.

IT WOULD be difficult to name a commodity that has more diversified uses than glycerine. This sirupy, odorless, viscous liquid that derives its name from the Greek word meaning "sweet," is a constituent of drugs, foods, and explosives, and enters into the make-up or processing of literally thousands of things. It is, incidentally, a member of the alcohol family. Two members of the staff of the Glycerine Producers' Association have prepared an article that covers the high points of this useful chemical.

IN THE short span of two decades, phosphate mining flourished and died in Quebec, Canada—an episode revived by R. C. Rowe in his article on *A Forgotten Mining Field*.

THE South American republics, although rich in untouched mineral resources, have limited coal deposits. Charles A. Howard, technical director of the Inter-American Development Commission, gives us the answer to their problem in *Postwar Electrification in South America*.

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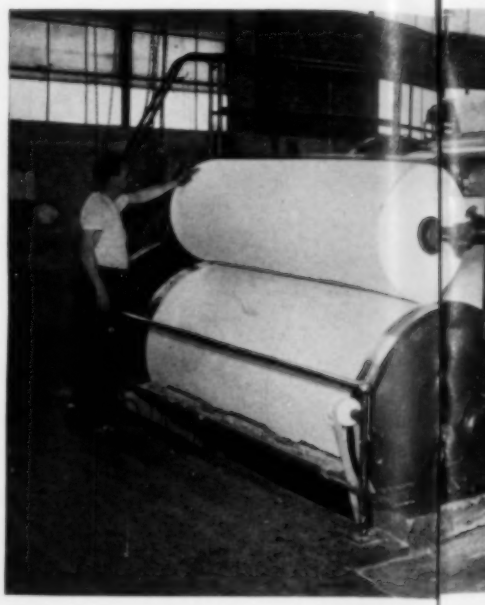


Cigarette P

C. H. Vivian

Photo, Ewing Galloway

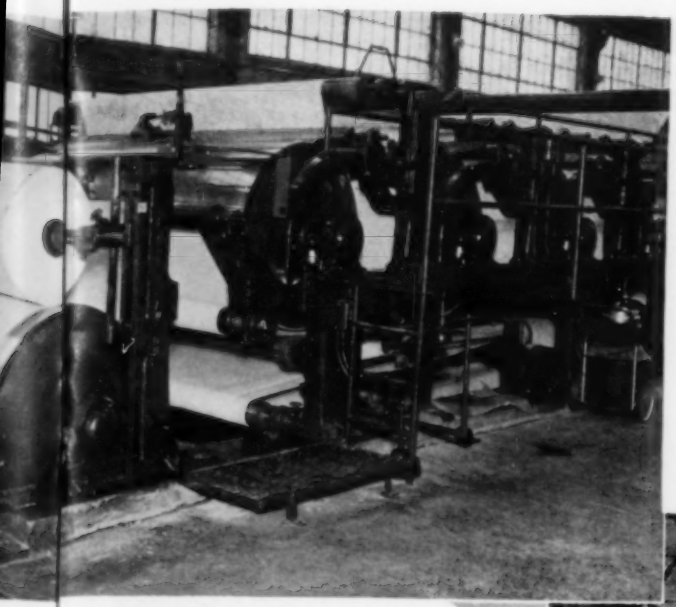
DURING the first World War our entire supply of cigarette paper was imported, and the cost rose to about six times the normal rate. In the present war, with our consumption meanwhile having risen precipitously, American mills are turning out all the cigarette paper we require at substantially the prewar price. And the present outlook is that this important commodity, like numerous others that we once obtained from abroad, will henceforth be made at home. Not only are we manufacturing all our own cigarette paper, but we are also furnishing much of the rest of the world with it. Moreover, we are making a better product than was heretofore available; and, thanks to American research, we are fabricating the paper from a raw material that was formerly valueless. As a result, American farmers are receiving a windfall income.

Until about three years ago, all cigarette paper was made from linen rags. The United States was never a linen-producing country, so it was only natural that this branch of the papermaking industry should have become seated in Europe, where an abundant supply of linen rags was at hand. France became the leading manufacturing nation, and into its mills flowed cast-off linen gathered throughout the continent by rag-pickers.

Because of the difficulties encountered in obtaining an adequate quantity of cigarette paper during the previous war, American importers realized that it would be advantageous to establish mills in this country. Among them was Peter J. Schweitzer, who had started dealing in foreign-made paper in 1912 and had grown to be the largest importer in the trade. In preparation for setting up manufacturing facilities here, he sent two of his sons, Louis and William, to the University of Maine, where a course in papermaking was available. Louis, the oldest and first to be graduated, then went to France to continue his technical studies at the University of Grenoble and, finally, to serve a year's apprenticeship at a mill in southern France in which his father held a controlling interest.

Upon Louis's return, the elder Mr. Schweitzer acquired a mill in Jersey City, N. J., that had been run by the Stratford Paper Company. There, with the help of his sons, he embarked, in 1920, upon the manufacture of two grades of thin linen paper, both of which were at that time being imported in large quantities. One was cigarette paper and the other was condenser paper. The latter is about one-third as thick as cigarette paper and is used in the electrical industry for insulating purposes.

Peter J. Schweitzer died in 1922, and his sons continued what was then an uncertain venture. The Jersey City mill

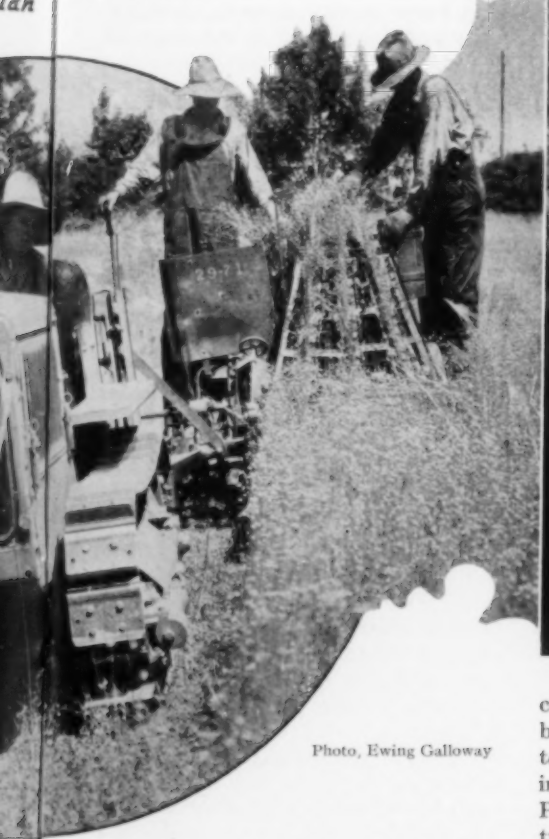


FROM FLAX TO ASHES

Flax, which has been cultivated for at least 4,000 years, provided linen for the ancient Egyptians and on through the ages for most of the world, and it was not until the eighteenth century that it was supplanted by cotton as the leading textile of commerce. European nations have always grown much flax, Russia having been the leader for many years. In the United States, flax has been cultivated well-nigh exclusively for the oil contained in its seeds, and the stalks were a waste product until the new technique of making cigarette paper directly from the fiber instead of from linen rags was developed three years ago. Most of the flax used by Peter J. Schweitzer, Inc., is grown in Minnesota. The plant, which requires warm days and cool nights, attains a height of from 20 to 30 inches. The fiber is about 80 per cent cellulose and has all the requirements for making fine paper. In the bottom-center picture we see flax being harvested in Oregon. Before it is shipped to the paper mill it is decorticated to remove as much as possible of the woody core. Then it is compressed into bales of 160 pounds each, quantities of which are shown below in the Schweitzer warehouse at Spotswood, N. J. By the method now practiced the fiber is converted in less than 36 hours into high-grade cigarette paper such as that shown coming off one of the machines (left) at Spotswood.

te **Paper**

ian



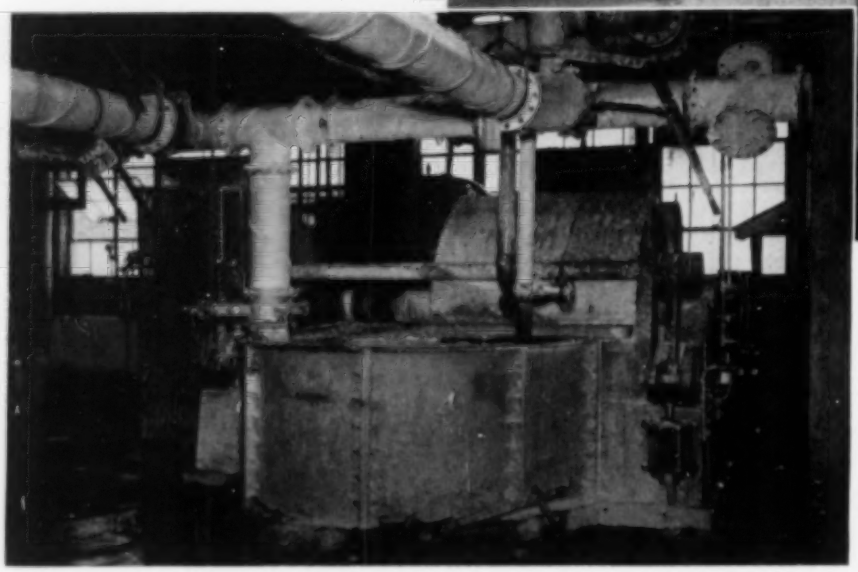
Photo, Ewing Galloway

was using the French method of making paper from linen rags, most of which were imported. The products were good, but American cigarette manufacturers had always obtained their paper from France and they were reluctant to make a change. It was only after a period that Louis Schweitzer characterizes as "tough sledding" that some of the bias was overcome and the enterprise reached a firm basis. During the years that have intervened, the original mill has grown into four plants; a third brother, M. Peter, has come into the business; and two companies—Peter J. Schweitzer, Inc., and the Schweitzer Paper Company—have been formed. A third product, paper to be carbonized for copy or manifolding work, has been added. We are concerned here only with the cigarette paper produced by Peter J. Schweitzer, Inc., at the Elizabeth mill and at a new plant in Spotswood, both in New Jersey.

Other domestic cigarette-paper plants had sprung up following the first World War, but as late as 1939 American cigarette manufacturers were still getting 80 per cent of their supply from abroad. It had been apparent, though, for several years that war clouds were again gathering over Europe, and American papermakers had been diligently searching for ways to meet the impending emergency. No one could foresee the seizure of France by Germany, but previous experience had made it plain that it would be difficult to import paper even if France remained free. The tobacco companies also realized that it would be necessary to establish greater domestic

PROCESSING THE FIBER

In the picture at the right is one of the two spherical cookers or digesters in which the flax fiber is treated with chemical reagents under heat and pressure to convert the noncellulose material into a form in which it can be removed by the subsequent operation of washing. The washed and bleached fiber is then prepared for the paper machines by beating, a process that cuts and brushes it to reduce it to myriads of minute pieces that will intermesh to form a thin yet firm and strong product. One of the six beaters is shown below.



manufacturing facilities, and they encouraged the papermakers in their efforts.

The result of this combined approach to the problem was the development of a radically new process of making cigarette paper directly from flax. This was a dire necessity, for the supply of linen rags in the United States was far from sufficient to make all the paper required; and wartime conditions presented an almost insurmountable obstacle to the importation of rags. A considerable amount of flax was being grown in this country, but mainly to obtain seeds for processing into linseed oil. The flax stalks, from which linen is produced in other parts of the world, were being discarded or burned here as waste.

Several papermakers, working independently, began investigations virtually simultaneously in an attempt to find a way to utilize the stalks. The crux of the problem was to devise a method of separating the fibers from their central woody core. In making linen abroad, this separation is done by peasants and is a slow and tedious process that is entirely out of keeping with modern manufacturing methods. Also, flax grown for that purpose is harvested before the seeds fully mature, for then the stalks are more susceptible to treatment than when they are older. The search for suitable mechanical or chemical means of separation was a long and at times a disheartening one, but it was obviously successful in the end. The operation is now performed in a few hours by cooking flax straw under pressure with special chemicals.

The result of this revolutionary process is that all our cigarette paper, which right now means most of the world production, is made from pulp obtained directly from flax straw. Farmers used to spend around $1.50 an acre to get rid of the straw; now they receive $2 or more for it, so they are at least $3.50 an acre to the good. The cigarette manufacturers who use the paper were a little doubtful about the quality of the new product when it was first offered to them, but agreed after extensive trials that it is superior to that formerly imported.

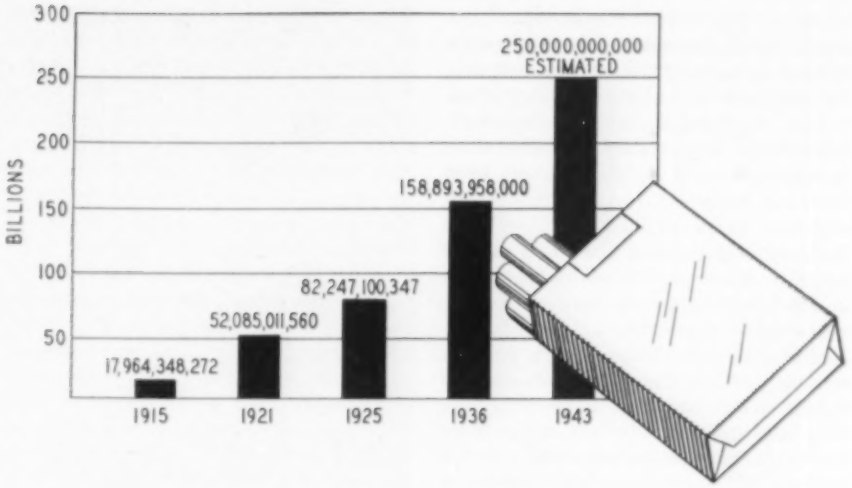
To be satisfactory, cigarette paper must be tasteless and odorless and possess a high degree of whiteness and opacity. It must have sufficient tensile strength and elasticity to withstand the stresses imposed upon it in the high-speed cigarette-making machinery now in use. It must not cling to the lips when moistened and must burn at the same rate as the tobacco, or the cigarette will go out quickly when not being smoked. This latter quality depends upon porosity and is imparted to the paper in two ways. It depends partly upon the manner in which the flax fiber is processed, but mostly upon the incorporation in the paper during manufacture of a definite proportion of calcium carbonate.

The wettability of the paper also is an important consideration. There are "dry" and "wet" smokers, and the latter will soon have the end of a cigarette soggy unless the paper is somewhat nonabsorbent. In this connection it is of interest to note that a moisture-resistant cigarette paper is now being made under patents held by the Schweitzer organization It is being used by one American cigarette manufacturer on a brand called "Military Marvels." These can be smoked in wet weather or handled with wet hands, and they have found favor with sailors on convoy duty and other servicemen who are exposed to bad weather conditions. The paper is also being furnished to some Canadian cigarette makers who sell their product not only to servicemen but also to civilians in some sections of the North Country.

Cigarette paper is slightly more than one-thousandth of an inch thick, and a ream, or 500 sheets of it 20x30 inches in size, weighs 9 pounds. On a comparable basis, it is about 24 per cent as heavy as the paper on which this page is printed. For some reason, cigarette paper has often been referred to as "rice paper," although it has no connection with rice or with the rice plant. The name probably came about through the fact that the Chinese formerly made from rice straw a thin paper that bore some resemblance to cigarette paper. Although

the bulk of the present-day cigarette paper is that with which smokers in the United States are familiar, some special types are produced for consumption elsewhere. South American cigarettes are encased in a brown paper, sweetened with saccharine and nitrated to assist the burning of the native tobacco, which burns slower than ours. So-called booklet papers, which are employed by those who "roll their own," contain no calcium carbonate, which explains why a handmade cigarette goes out unless it is puffed frequently.

In taking over the manufacture of cigarette paper, Americans have, as is often the case, improved the process in various ways. In France, the methods and procedure had become more or less static. The art of making the paper had been handed down from father to son through generations, and its quality depended primarily upon the skill of the individual workmen. Our technologists have substituted scientific methods for this personal touch, with the result that they have departed from some long-established French practices. It was customary in France to run the paper-making machines at a speed of about 100 feet per minute. That rate had always been standard, and nobody would change it. American mills operate theirs at several times that speed and increase unit production proportionately. They are also using wider machines, which further steps up output. Although the continual speeding up of cigarette-making machines has placed greater strain on the paper, our technologists have been able to offset this by giving it added strength without increasing the thickness or weight.



UNITED STATES PRODUCTION OF TAX-PAID CIGARETTES

The figure for 1943 does not include huge quantities of tax-free cigarettes that are being shipped abroad to the military forces of the United Nations.

As is pointed out in an accompanying illustration, the production of cigarettes in the United States has been growing at an amazing pace. Reuben R. Thompson, editor of the authoritative trade journal *Tobacco*, estimates that the 1943 output is at the rate of nearly 1,000,000,000 daily. Exact figures are unobtainable, as government reports cover only tax-paid cigarettes. The total of these for the eight months ending August 31 was 164,533,465,510, or at the rate of around 250,000,000,000 for the full year. In addition, huge quantities of tax-free cigarettes are going to our military forces and to those of our Allies under lend-lease agreement. August production of tax-paid cigarettes was 23,681,911,319, a new high monthly total and an increase of 13.09 per cent over August, 1942.

The growth in popularity of the cigarette has been intimately associated with wars. The idea of wrapping tobacco in a paper tube is said to have originated in Brazil, in the eighteenth century, and the product was called *papelito*. The use of cigarettes gradually spread to Continental Europe, but the British stuck to cigars and pipes until the Crimean War of 1856, when Tommy Atkins learned from Turkish soldiers how to "roll their own." Napoleon III, Emperor of France, was the first state dignitary to smoke cigarettes, and his example was followed by numerous Europeans. The custom was then adopted in the United States, but made comparatively little headway until the first World War, when women as well as men took to it. Then followed the tremendous growth that has brought about today's staggering statistics. The Government has sounded a warning, however, that there is to be a reversal in the trend so far as the United States is concerned. The smoking increase here, coupled with the shipment of cigarette tobacco abroad, has caused manufacturers to draw upon reserve stocks, and a shortage is in the offing. The Department of Commerce estimates that, if the use of reserve stocks continues, cigarette makers may have to get along on 58 per cent as much tobacco next year as was raised in 1942, which presages a 42 per cent drop in the supply of cigarettes available for Americans. It is expected that the shortage will begin to make itself felt soon after the beginning of the new year.

The production of cigarette paper has, of course, been rising in direct ratio to the cigarette output. No official figures are obtainable; but, according to estimates within the industry, current production is around 75 tons daily. For those who like statistics, we record that 1,000,000,000 cigarettes a day means

MACHINE ROOM

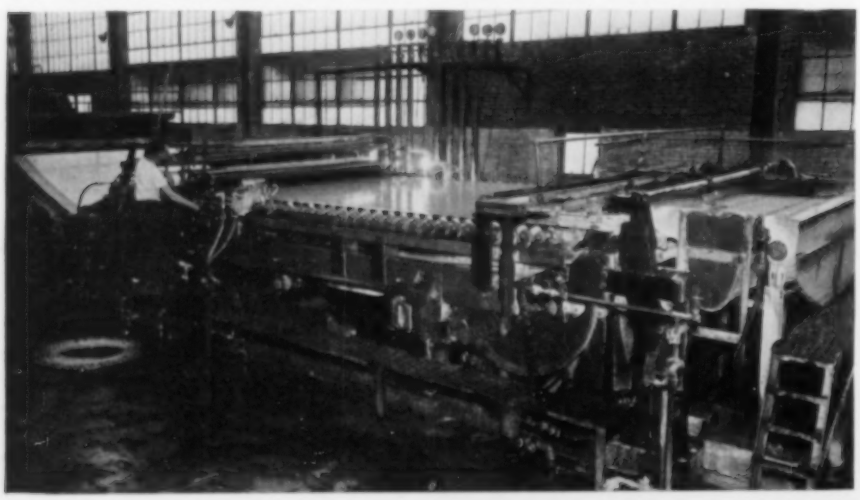
General view of the two Fourdrinier paper machines taken from the wet end. At the head of each is a centrifuge and screen for sizing the pulp and a head box from which it is distributed to the wire screen on which the paper is formed.

about 7.7 per United States capita and that some 43,400 miles of cigarette paper is used in making them. These figures do not include hand-rolled cigarettes.

The Spotswood mill of Peter J. Schweitzer, Inc., is one of the most modern plants of its kind, having been laid out expressly for the making of cigarette paper directly from flax. The buildings were originally erected in 1929 by the American Salpa Company, a concern backed by the Italian Government and organized to manufacture artificial leather. Funds for its support were cut off less than a year after it had begun to operate, and the facilities lay idle until the property was acquired by the Schweitzer interests in 1941. As the process of making artificial leather is generally similar to that of manufacturing paper, the plant was admirably suited for its present use; in fact, to the casual visitor it would seem to have been designed for it.

The property consists of 62 acres with modern buildings affording 354,000 square feet of floor space. As a considerable quantity of steam is required in papermaking, a power plant is essential. The steam is first used to drive generating equipment that furnishes some of the mill's power needs. An ample supply of water is also required and is obtained from wells. The consumption amounts to 2,500 gpm., or 150 gallons for each pound of paper turned out, and is probably as high a ratio as is found in any branch of the paper-manufacturing industry. The water has a high degree of purity, which is essential to the production of a tasteless, odorless paper. It is especially desirable that no iron be present.

The entire process of converting flax into cigarette paper at Spotswood takes less than 36 hours. As received and placed in storage, the flax is that part of the stalk that has been removed from the surface of the woody core, and the light-brown fibers that constitute the papermaking material are readily visible. Flax is withdrawn from the warehouse as needed, and is elevated to the third floor of the mill where, together with chemical reagents and water, it is charged into a cooker or digester. There are two of these vessels, and one is in operation while the other one is being filled. Each cooker is made of curved sections of heavy steel plate welded together to form a perfect ball, 18 feet in diameter, that holds 20,000 pounds of flax fiber. It is mounted on trunnions, attached at the center on each side, and is rotated vertically at slow speed by a motor that turns it through gears. By means of steam that is piped into it through one of the trunnions, the interior is brought up to the required pressure and temperature. Under these conditions the fiber is cooked for about ten hours. The liquor breaks down and dissolves the noncellulose materials—puts them in a state where they can be removed, thus leaving the cellulose fibers desired for papermaking.



WHERE PAPER IS FORMED

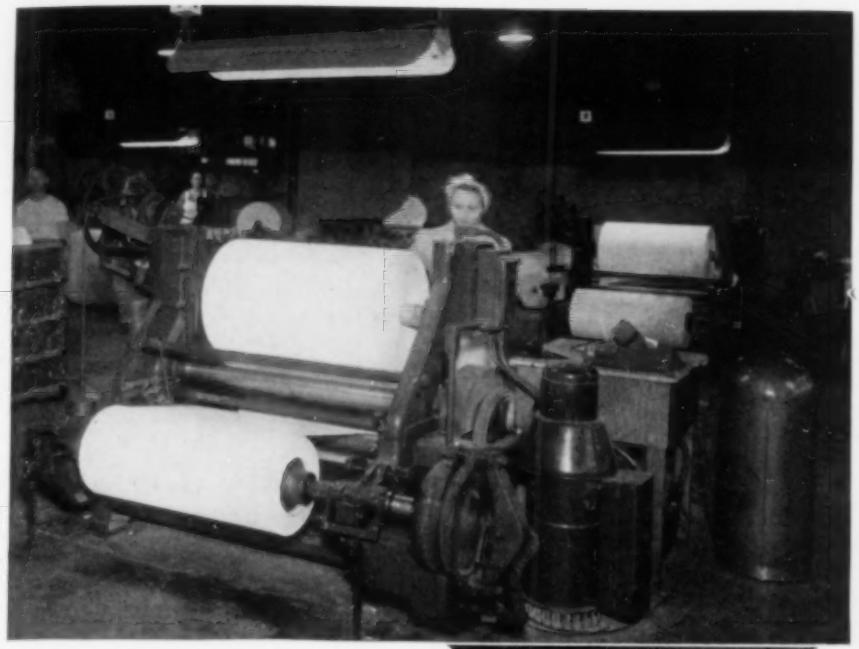
Close view of the wet end of one of the machines. At the right is the head box containing the stock, which is made up of 199 parts water to 1 part fiber and calcium carbonate. As the stock flows from the head box it is distributed evenly over the wire screen by two slices or gates. The screen, composed of finely meshed brass wires, carries the stock along and at the same time oscillates from side to side, thus crisscrossing the fibers and intermeshing them to form paper. The white object at the right of the operator's hand is a water jet that plays upon the edge of the forming sheet, cutting it off clean and even. A similar apparatus is mounted on the opposite side. As the stock moves along, the excess water drains through the screen. This so-called "white water" contains fine pieces of fiber and is used over again, thus not only eliminating waste but improving the quality of the paper. Just in front of the operator is the verge roll which watermarks the paper with the characteristic series of closely spaced lines. Beyond the operator, the sheet of paper may be seen starting on its journey through the dry end of the machine.

After being cooked, the contents of the vessel are dumped into a washing vat directly underneath it. The vat is oval-shaped and divided longitudinally in the middle. A propeller-type agitator, which is essentially a large paddle wheel, keeps the material circulating. Liquid is drawn off at one stage in the cycle while an equal volume of clean water is added at another. This washing process is continued for twelve hours and serves to remove a large proportion of the noncellulose content. The remainder is removed during the next step, which is bleaching. This takes place in tanks similar to those used for washing. Chlorine and hypochlorites are the bleaching reagents, and these not only rid the cellulose of the brown coloring matter but also render the remaining impurities soluble so that they can be readily washed out. The pulp is now ready for the first step in the papermaking process, and its weight is approximately half that of the original charge of flax, or 10,000 pounds.

Before the pulp can be made into paper, the cellulose fibers must be shortened and separated to produce a uniform, finely divided material. This is done in beaters or beating engines, as they are known. These are tile-lined, oval-shaped vats in which the pulp, borne by water, moves over and over again underneath a revolving cylinder on which knives are mounted. The knives bear against a bedplate, and the action is one of both cutting and brushing out the fibers so as to break down each one into myriads of smaller fibers. Beating has the further effect of hydrating the fibers, that is, bringing about a chemical union between them and minute quantities of water. Hydration imparts added strength and a smoother finish to the paper.

Following beating, which is prolonged for several hours, calcium carbonate is added in an amount sufficient so that about 20 per cent will remain in the finished paper. The pulp is now pumped to large tanks known as machine chests, from which it is fed to the papermaking machines. It is agitated continually in the tanks to prevent settling and consists of 199 parts water and 1 part pulp.

There are two papermaking machines of American manufacture in use, and these are of the conventional Fourdrinier type, with special features of design required for making cigarette paper. Interposed between the machine chest and the papermaking machine are two devices for removing oversize fibers, excess chalk, and extraneous materials. The first of these is a centrifuge in which the pulp is subjected to centrifugal action, and the second is a revolving screen. From the latter the pulp flows to a tank called a head box, which feeds it to a traveling screen that is the first unit of the paper machine. Even distribution of the pulp is effected by two "slices,"

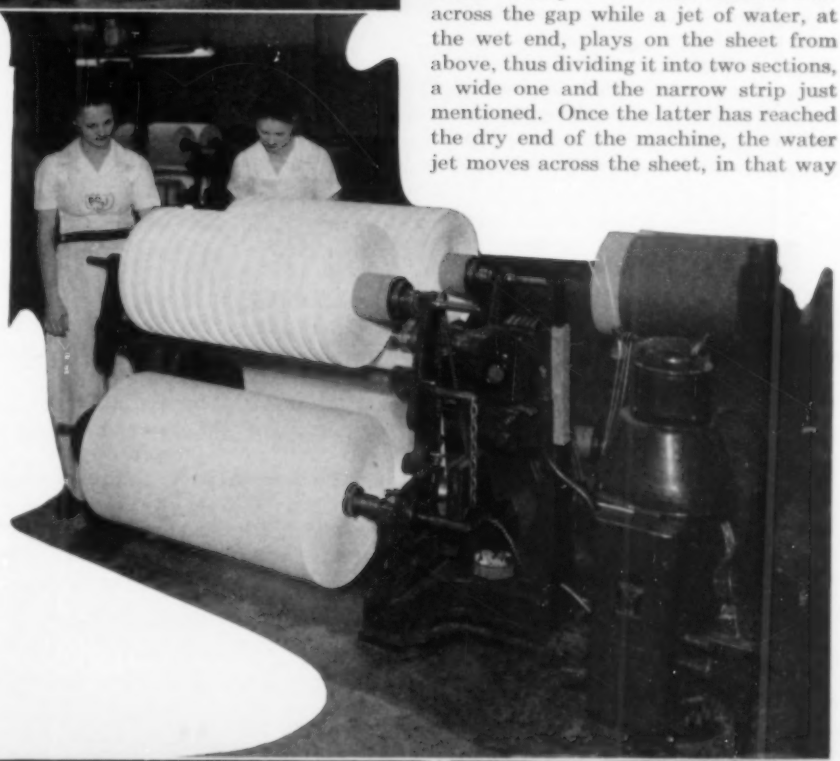


which are merely head gates set with sufficient clearance to regulate the volume of the feed, as desired. The first slice is disposed vertically, while the second one, a few inches away, is inclined in the direction of flow.

The screen, which is called the "wire" in paper-mill parlance, is woven from brass wires, 96x100 to the linear inch. It is continuous and, although only 12 or 15 feet long, the paper is actually formed on it. To bring about a better interweaving or felting of the cellulose fibers, the screen is oscillated laterally while traveling longitudinally, this action being termed the "shake." As the screen moves along, any excess water passes through it, leaving a fine film of fiber on it.

Near the end of the screen's travel, the pulp passes under a "dandy" roll, a precisely formed cylinder made up essentially of fine wire. This impresses in the pulp the series of watermarks which are distinctive of cigarette paper but which serve no useful purpose so far as the papermaker knows. These marks consist of closely spaced lines that can be observed encircling a cigarette and of an occasional line running at right angles to the first series. This watermarking is termed the "vergé," and the roll that makes it is the "vergé dandy roll." After passing under this roll, the pulp goes between a pair of rolls which squeeze out excess water. It is then ready to leave the "wet" end of the machine and pass to the "dry" end.

To reach the dry end, the film of what is now really moist paper must span a gap of about 6 inches to a traveling, continuous web of felt on which it is supported during the remainder of its journey. When moving, the paper is strong enough to hold together while passing across this open space; but when a machine is shut down for any reason there is a break at that point and an interesting use of compressed air comes into play. Air emitted through openings beneath one edge of the sheet literally floats a strip of it a few inches wide across the gap while a jet of water, at the wet end, plays on the sheet from above, thus dividing it into two sections, a wide one and the narrow strip just mentioned. Once the latter has reached the dry end of the machine, the water jet moves across the sheet, in that way



FINISHING OPERATIONS

The paper is made 110 inches wide and slit into three equal parts, each a little less than 37 inches wide. These rolls are then rewound to smooth out irregularities, to remove defective sections, and to mend breaks. Rewinding is shown at the top, where the paper is being transferred from the lower roll to the upper one. Each of these rewound rolls is then slit into strips 1.14 inches wide, which are wound into bobbins ready for the cigarette-making machine. This operation is illustrated at the center. It will be noted that alternating strips are wound on different reels, leaving a space between bobbins. The latter are carefully inspected, packed in cartons, and placed on a conveyor belt that moves them to the shipping room, right.

TESTING THE PAPER

A view of one corner of the control laboratory where samples, taken from each machine at hourly intervals, are carefully checked against established standards. The machine shown tests a strip of paper of the width used in cigarette-making for tensile strength and elasticity. The laboratory is maintained at constant temperature and humidity.

progressively increasing the width of the narrow strip. This continues until the cohesion of the moist paper is sufficient in itself to effect the transfer of the sheet. Actually, this operation is carried out in a matter of seconds.

The felt carries the paper to a pair of suction press rolls. Several series of these rolls are employed in making some kinds of papers; but cigarette paper, being of a soft variety, requires only the one pressing operation. The end of the machine consists of seven large-diameter drying rolls. These are internally heated with steam, and by the time the paper has passed over them it is dry enough for use. As formed on the Fourdrinier, the paper web is 110 inches wide, but just prior to being reeled on to a roll where it leaves the machine it is slit into three equal widths.

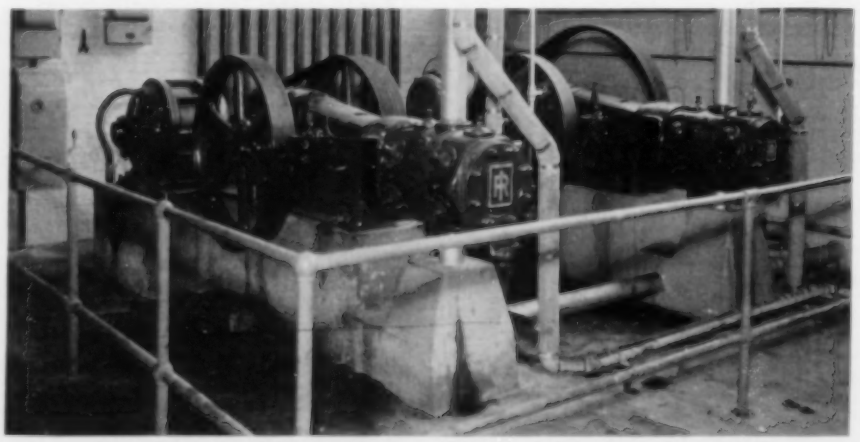
The remainder of the operations come under the head of finishing, and the first of them is rewinding. As the paper passes from reel to reel it is under continual visual inspection, and any defective sections are eliminated. Breaks in a strip are repaired by joining the ends carefully with cellulose paste, which is thoroughly dried by a current of warm air from a portable appliance before reeling proceeds. The rewound roll thus contains a continuous strip of paper that is free from imperfections and reeled perfectly smooth and even. It is a little less than 37 inches long and approximately 34 inches in diameter, or one-third the length of the roll that came from the paper machine.

Each rewound roll is next further divided into reels or bobbins of paper of the exact width required by the cigarette-making machines. This is a combined rewinding and slitting operation. As the paper comes off the roll, knives cut it cleanly into strips 29 millimeters (1.14 inches) wide, and these are rewound as shown in an accompanying illustration. A bobbin intended for American cigarette-making machines holds 6,000 meters (19,685 feet) of strip. This will make 85,900 cigarettes of standard length (2.75 inches), or 71,311 of the so-called king size that has recently been introduced by some manufacturers. Bobbins for use in other countries are of varying sizes. Wherever a break in the paper is mended during the rewinding process, a strip of colored paper is inserted. These markers are retained in the finished bobbins in order that the cigarettes encased in the mended paper may be detected and removed before packaging.

Rigid laboratory control is exercised over the paper at several stages in the manufacturing process. Chemical analyses are run on each batch of fiber that is cooked, and it is checked closely through all the succeeding operations. Samples of finished paper are taken from each machine every hour and tested in an adjacent laboratory for width, weight, chalk content, density, opacity, whiteness, tensile strength, bursting strength, stretch, and capacity for folding without damage. The appearance of the paper is also observed and noted on the report under the headings of texture, pinholes, and spots.

Every part of the mill except the finishing department is operated 24 hours a day—the finishers being able to handle in one shift all the paper that is produced in a full day. The Schweitzer companies have received national recognition for their employee-relations policies. They were the first in the country to institute paid-up hospitalization benefits for employees and their families. This includes both medical and surgical treatment. Each employee is given a paid-up life insurance policy. Vacations with pay are granted all workers who have had one year of service. At Christmastime there is distributed a cash bonus that amounts to one week's pay for all employees that have worked between six months and one year and two weeks' pay for those that have served a year. There is in force an employee-retirement plan by which workers participate after they have had five years of service. In addition to these established benefits, it is the policy to pay the highest prevailing wage rate in the paper industry. Anyone who has reason to believe that someone performing the same work in another organization is getting more pay then he is informs the management. The facts are then checked, and any difference found is immediately equalized. A liberal loan arrangement also enables employees needing money for any legitimate purpose to obtain it from the office without red tape, usually involving only a brief conference between the worker and the plant manager. Needless to say, the Schweitzer mills have not had to contend with labor shortage and absenteeism.

Louis Schweitzer is president of Peter J. Schweitzer, Inc.; William P. Schweitzer, now serving as a major in the Army Signal Corps, is vice-president; and M. Peter Schweitzer is secretary. Executive offices are maintained in New York, N. Y., and at Elizabeth, N. J. Albert Lowing is manager of the Spotswood mill.

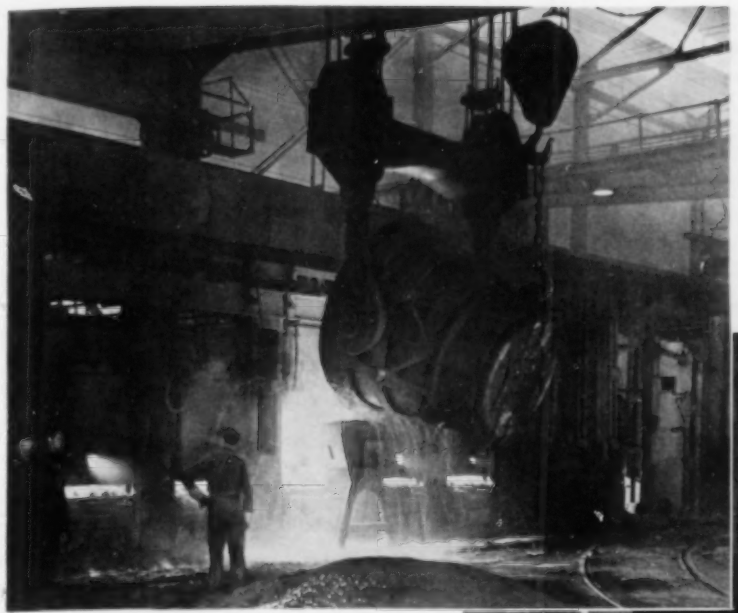


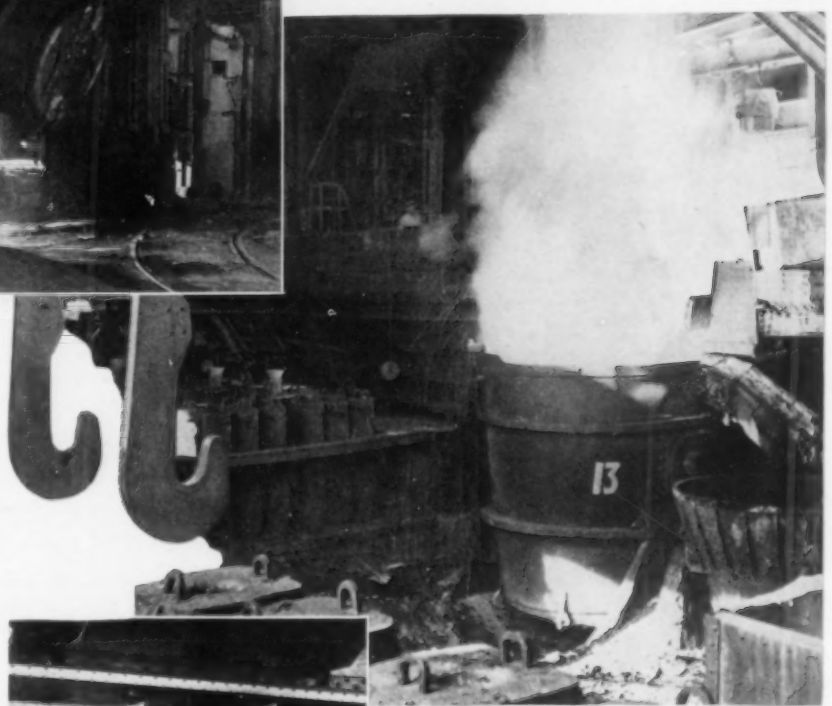
AIR COMPRESSORS

Compressed air operates control units throughout the mill and level gauges on the paper machines; is essential to the functioning of the fire-protection sprinkler system in the offices and flax warehouse; and is used for cleaning machines and for operating various kinds of tools required for plant maintenance. The air is supplied by these two Class ES-1, 30-hp., units each of which has a piston displacement of 211 cfm.

Seamless and Welded Steel Pipe

*Elmer T. Wible**





PREPARING THE STEEL

Tubing is formed from billets or from skelp that has been rolled from billets. Preliminary processes consist of smelting the iron ore—making the steel—and of saturating the ingots with heat so that they can be properly worked. These pictures show an open-hearth furnace (above) being charged with hot iron from a blast furnace; steel being tapped from an open-hearth furnace (right); and an ingot of steel being withdrawn from a soaking pit (bottom) where it has been brought to a uniform temperature throughout preparatory to being rolled first into blooms and then billets.

STEEL tubing, which the maker of boilers, heat exchangers, cracking stills, and similar equipment considers raw material, is a highly finished product from the viewpoint of the steel manufacturer whose raw materials are iron ore, coke, gas, limestone, scrap, ferroalloys, etc. The iron ore is processed in blast furnaces into crude iron or pig iron which, along with selected scrap, alloy metals, etc., is charged into open-hearth furnaces and refined into steel. The latter is cast into ingots; "soaked" in reheating ovens to a uniform temperature throughout; and rolled into blooms, billets, and rounds for seamless tubing, or into billets, slabs, and skelp for welded tubes. The foregoing, obviously, is not intended to be a comprehensive discussion of steelmaking; our primary purpose is to devote the available space specifically to the manufacture of tubing. Also, we have omitted mention of electric and Bessemer-steel furnaces, for both of these are relatively small factors in the production of tube steel.

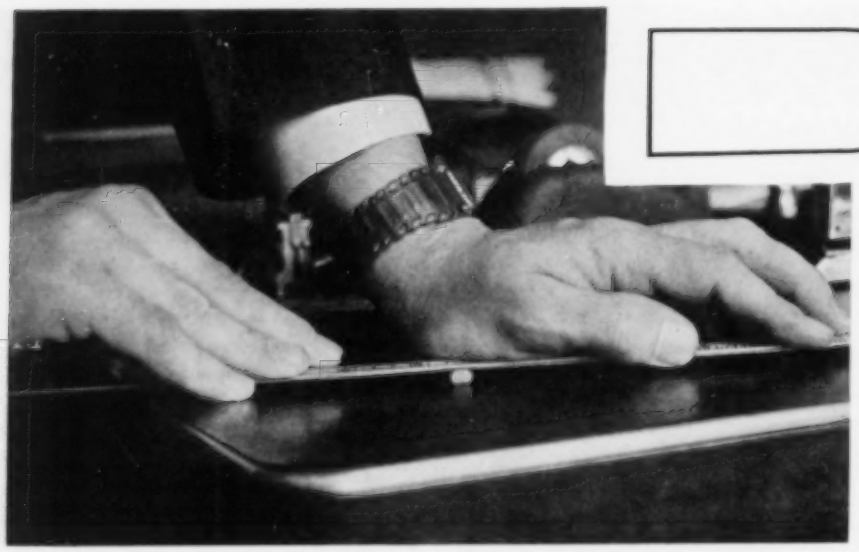
It should be explained that tubing is similar to pipe and that it is not possible by definition precisely to distinguish one from the other. Pipe, subject to several exceptions, is a tubular-steel product that is known by its nominal inside diameter; that is, 1-inch standard pipe has an inside diameter of approximately 1 inch. Tubing also is a tubular-steel product, but it is usually referred to by its outside diameter and requires greater accuracy in all its dimensions.

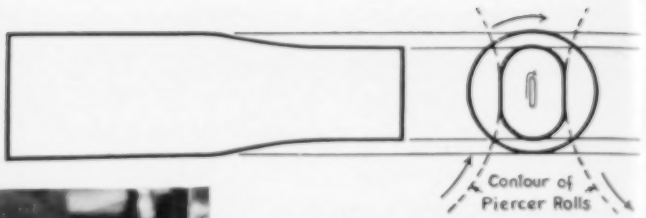
Seamless-steel tubing is just what the name implies. It is made by putting a hole in solid steel rather than by joining or welding edges of formed strip. This is done variously, but as the tonnage output of all but the roll-piercing method is insignificant, we shall confine this discussion to the latter.** Known as Mannesmann Roll-Piercing, the process involves the principles of both diagonal rolling and piercing. The work is done by two heavy, barrel-shaped rolls which taper at an angle of 5 to 10° toward each end from a flat central section about 1 inch wide. These rolls are placed in their housings side by side with their axes slightly askew and inclined in opposite directions but corresponding at their centers. The angles at which they are set obviously impart forward motion to the material being pierced.

The billet to be converted into a tube is uniformly heated and conveyed to a trough on the entry side of the rolls. There it is forced into an opening between the rolls. In this space is a pointed mandrel that is held in position by a water-cooled rod introduced from the delivery side of the rolls. The latter revolve rapidly, advancing the billet and compressing it into an oval shape at the narrowest point between the rolls. This tends to separate the fibers of steel at the center of the billet and to form an opening or tube even without the assistance of the piercing mandrel. Coincident with

*Manager Product Promotion, Pittsburgh Steel Co.

**Others include cupping and hot drawbench, hydraulic plunger and extrusion.





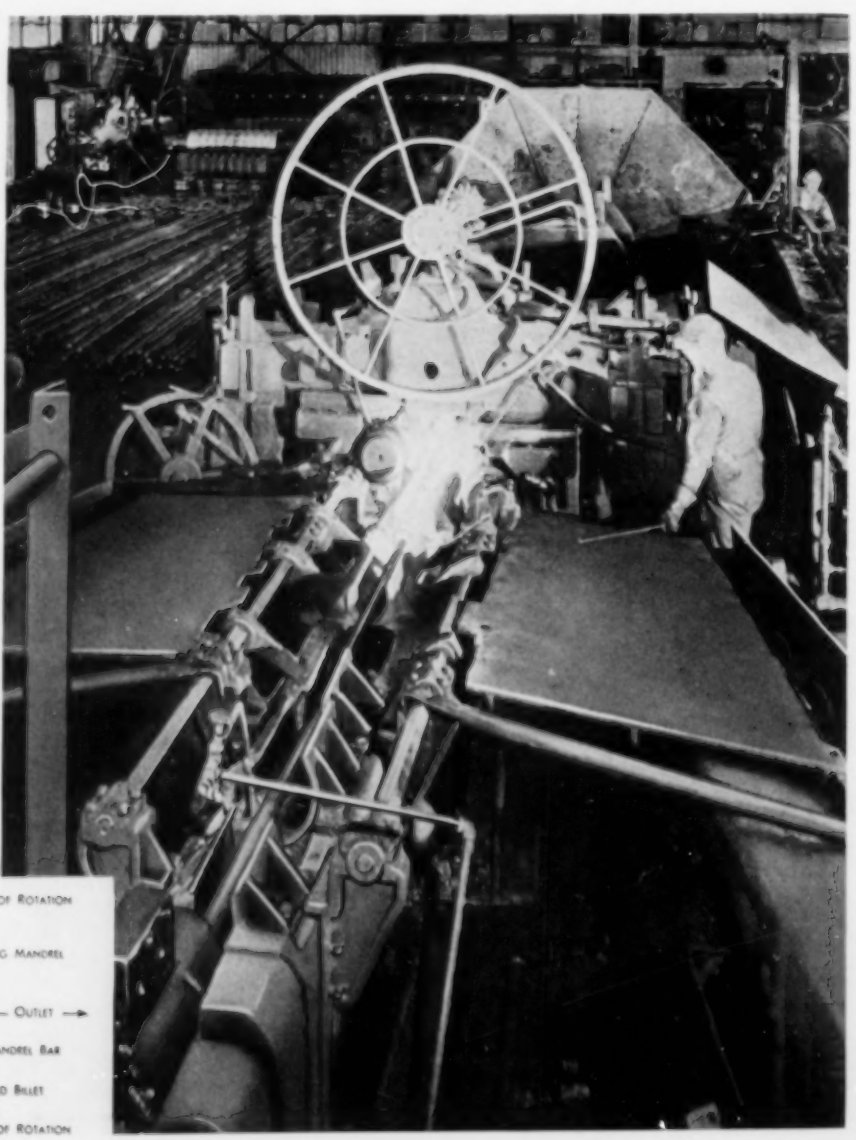
OPENING BILLET CENTER

When a round, solid steel billet is passed between the piercing rolls, it is compressed and becomes oval in shape. The rolling action tends to open it in the center, thus helping the mandrel in the work of piercing the billet from end to end. This can be demonstrated by vigorously rolling an ordinary pencil eraser with a ruler, as shown. The action, if continued, will progressively deepen the hole until it extends through the eraser.

this natural tendency of the steel to open up at the center, the mandrel causes the opening to assume a round shape with a comparatively smooth surface. As it emerges from the piercing mill the billet is an unfinished, thick-walled tube, ready for further rolling and finishing operations.

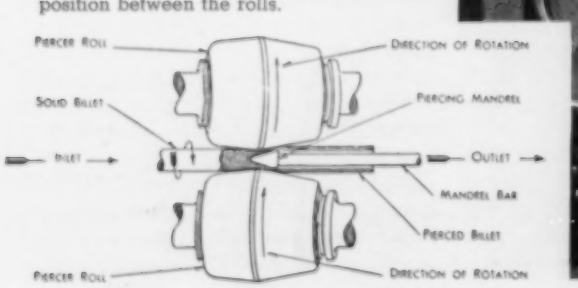
That the rolling of the billet is at least as important as the piercing operation may be illustrated with an ordinary pencil eraser. Roll an eraser vigorously between a ruler and a table, compressing it the while the same as the billet is compressed, and it will soon become a hollow tube. However, in the case of the hot metal tube, the separated steel fibers are molded into its inside wall by the piercing mandrel, and no steel is lost. It is obvious that the piercing of solid-steel billets is a severe test of their soundness. Any undetected imperfections in the solid blanks are almost sure to come to light during that operation, while sound steel is strengthened and refined as it is worked under closely determined temperatures during the rolling process.

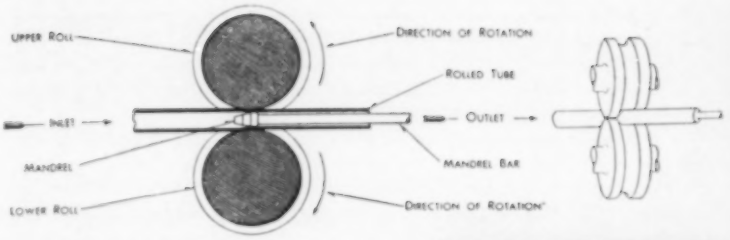
Upon leaving the Mannesmann piercer, the tube blank goes directly to the rolling mill, which consists of two long rolls arranged one above the other in the stand. Encircling each of these rolls is a series of grooves that become progressively smaller from end to end. With the rolls properly adjusted, each pair of grooves of corresponding size conjoins, thus forming a series of approximately round "passes" through which the hot blank is rolled successively until its length, diameter, and wall thickness closely approximate those of the finished



PIERCING

The rotation of heavy steel rollers, set at an angle to one another, imparts a forward motion to the billet, which is pierced by a pointed mandrel held in position between the rolls.





ROLLING

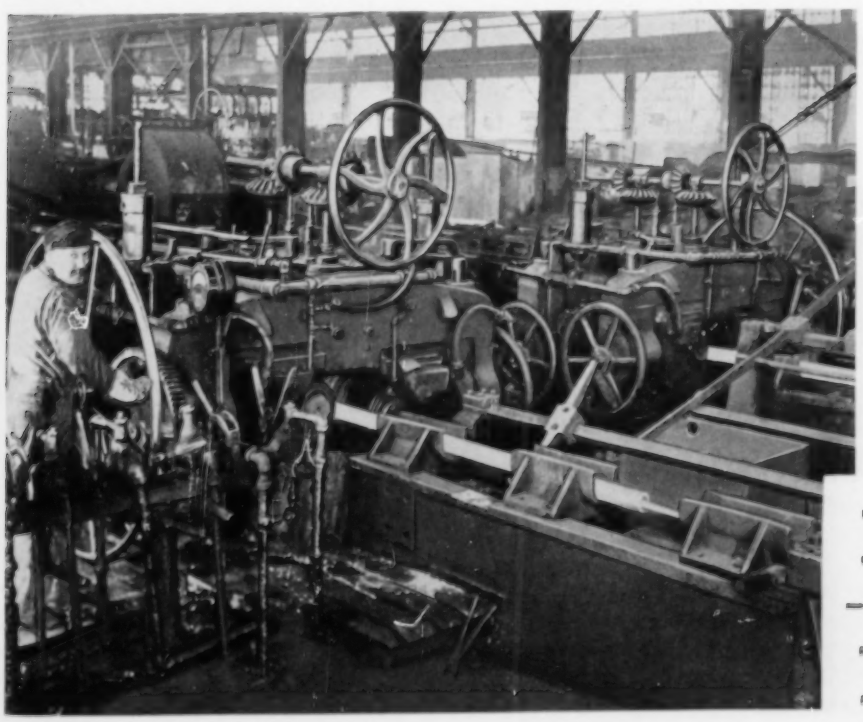
From the piercer, the still white-hot tube goes to the rolling mill where it is reduced in diameter and wall thickness and at the same time elongated by successive passes through rolls with grooves of progressively smaller size. During the process, the tube is supported inside by a mandrel.

product. Supported by a long rod at the rear of the mill is a mandrel or plug, the same as in the case of the piercing mill, over which the tube rolls with each pass.

In rolling, one end of the almost white-hot tube blank is introduced into the first and largest of the rolling-mill passes. When the rolls seize it and force it through, the tube is elongated as the extremely thick walls are rolled down over the mandrel to more nearly normal size. Returning automatically from the rear of the mill, the tube is given a 90° turn and introduced into the second pass, thus further reducing the outside diameter and wall thickness and increasing the length proportionately. The tube receives two or more rollings in the same way until it is of the proper size.

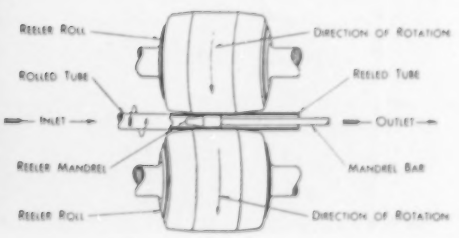
When the tube comes from the rolling mills it is slightly oval-shaped, oversize, and not perfectly smooth. To correct these conditions it is necessary to put it through three finishing operations, the first of which is "reeling." The mill that does this work has two short, heavy rolls mounted side by side and with their axes slightly inclined horizontally, thus crossing each other at their centers. Each is adjustable laterally so that the pass between them may be varied by thousandths of an inch. At the back of the rolls, a plug is supported on a mandrel bar, the same as at the roll mill. In operation, the tube, still retaining enough of its original billet heat to make it a cherry-red, is introduced into the reeling mill, where it is seized and forced between the swiftly revolving rolls, over the mandrel plug, and out of the mill. The tube is now perfectly round, practically straight, and highly burnished. It is still slightly oversize, however. This is remedied in the "sizing" mill.

Tubes that are 3 inches in diameter and larger go through a sizing mill having horizontal and vertical rolls that are set so that all the passes in the stand are in a horizontal line. The grooves that constitute the passes form a perfect round and give the finished tube the desired outside diameter. The tube is introduced into the sizing mill, this time without a mandrel, which draws it slowly



REELING

Rolled tubes are out of round, oversize, and rough inside and outside. These shortcomings are corrected by three finishing operations, the first of which is reeling. The tube, with a mandrel inside of it, passes between two heavy, barrel-shaped rolls that are set side by side and are capable of such delicate adjustment laterally that the space between them can be reduced to a few thousandths of an inch. The tube emerges practically straight and highly burnished but still slightly oversize. This is remedied by sizing or hot-reducing.



through, slightly compressing the oversize walls to give it the specified diameter. Tubes of less than 3-inch outside diameter are reheated and finished by a "hot-reducing" process. This is similar to the sizing operation, except that each of the eighteen stands of rolls in the hot-reducing mill offers a slightly smaller pass to the advancing tube. By this method it is possible to produce hot-rolled tubes as small as 1½ inches outside diameter.

These are basically the operations by which a solid billet is converted into a seamless tube by the conventional piercing and hot-finishing processes. There are certain modifications and refinements as to control of dimensions and physical properties that vary from mill to mill, but these are not pertinent to the present discussion.

In making welded tubing we start out with a flat-rolled strip or "skelp." The strip is generally received in coils from the steel mill where it is trimmed to the exact widths required for making tubes of specified diameters. The process of rolling steel and of converting it into flat-rolled, coiled stock assures a basic high-quality material of maximum strength, accurate gauge, and excellent surface. Each coil is provided with a tag that shows the analysis of the steel, its hardness, gauge thickness, and width.

To give the strip stock the desired circular cross section, it is fed successively through a pair of driving rolls and a series of forming rolls. The top and bottom forming rolls first encountered by the strip are opposite in contour, while the last are alike in form. In its passage through this series of rolls, the stock is gradually curved until it becomes tubular in shape. As the forming is done cold, any surface defects are magnified—they are not hidden or healed. These flaws are readily detected because both the inside and outside surfaces can be inspected nearly to the end of the forming operation.

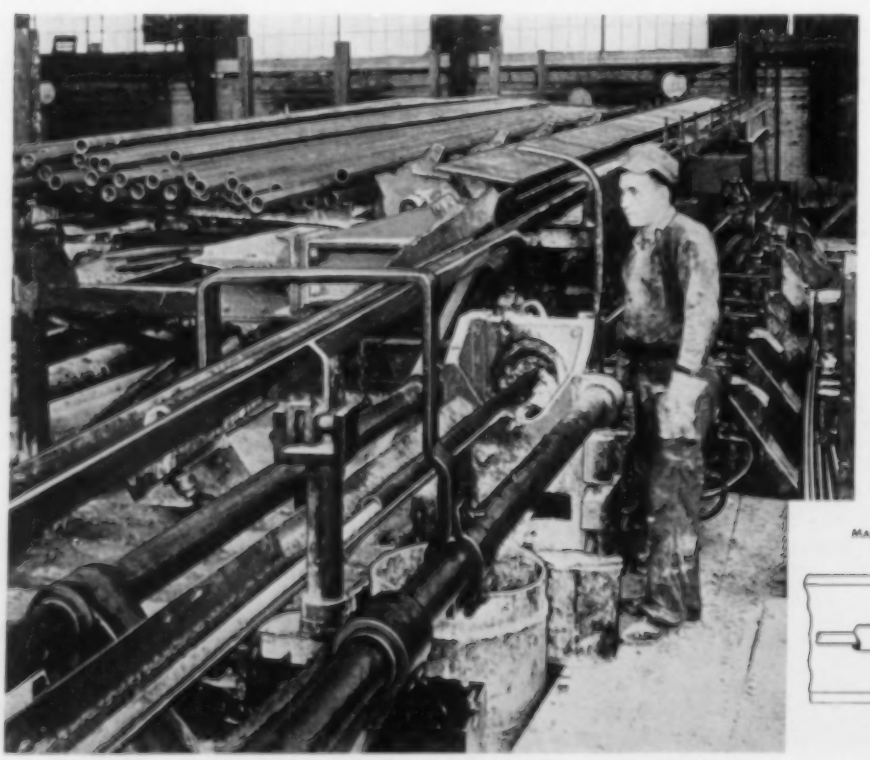
From the forming rolls the butted tube is passed through the welding section of the machine. Several different processes are employed to close the seam as the edges of the strip come together, and these include electric-resistance welding, atomic hydrogen arc welding, oxyacetylene and arc welding. We shall discuss in some detail the first and most widely used of these; the others have their specific applications in connection with special steels or conditions.

In electric-resistance welding, a supply of high-amperage current is connected to a pair of copper-alloy disks, which serve as electrodes and make contact with the two edges of the formed strip. The welding unit is adjustable, up and down, and the amount of current delivered to the electrodes, as well as the speed of operation, can be closely regulated. When the tubing passes under the electrodes, current automatically begins to flow and travels from one electrode to another across the seam cleft, creating heat through the resistance offered to the current by the edge surfaces. The moment the flow of current starts, side rolls exert sufficient pressure to bring the heated edges together and to form a welded joint. Because the material at the extreme edges of the butted joint is heated somewhat beyond the plastic state it is squeezed outward, and the union is made with unexposed metal that is in a plastic condition. Since only the edges of the tubing are brought to the welding temperature, the heat is quickly dissipated.

Excess metal or flash left on the inside and outside of the tubing by the welding operation is removed in several ways. However, in the case of tubing intended for certain applications, the manufacture of furniture, for example, the inside flash may be allowed to remain. By one method the flash is planed with suitable cutting tools conforming in contour to the tubing. Others involve smoothing it down while the tubing is still in the plastic state at the welded seam; applying planishing rolls both inside and outside; or swaging over a mandrel.

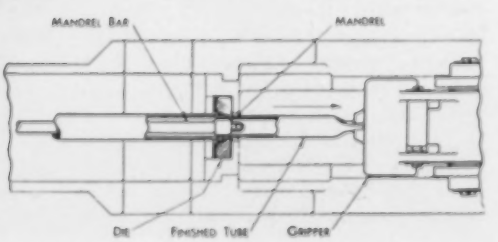
The product now reaches the cut-off machine, which moves with the tubing and cuts it into specific lengths. This phase of the work is usually such as to permit continuous operation of the entire forming and welding machine. To make certain that the tubing has the required physical properties, it is subjected to various routine tests—including expanding, flattening, crushing endwise, and flanging—each time a machine is started, as well as at stated intervals in the course of the operations. For all industrial applications, where resistance to severe corrosion is a factor, stainless-steel tubing is heat-treated following welding, swaging, drawing, or other mechanical working. Next it is pickled to remove scale and then immunized by dipping in nitric acid.

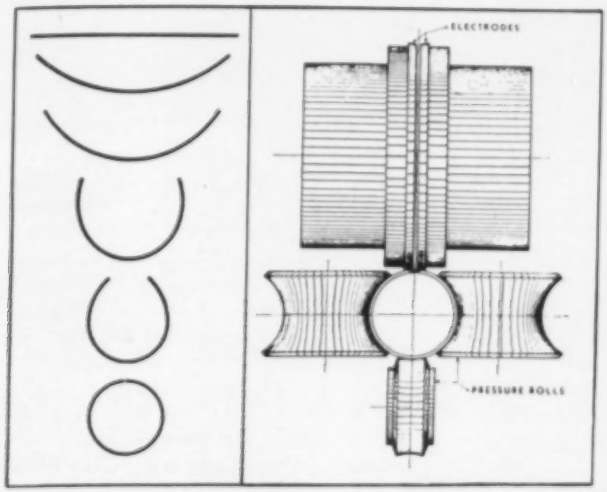
Investigations of the strength of welds in steel tubing were undertaken as early as 1920. In 1929 the U.S. Bureau of Standards made an extensive series of tests on carbon-steel tubing manufactured by the electric-resistance welding process and concluded that the weld is as strong as the wall and, so far as strength and other physical characteristics are concerned, has the same qualities as the steel from which it is made. In recent years there have been notable improvements in tube-mill equipment and control procedures, and these have

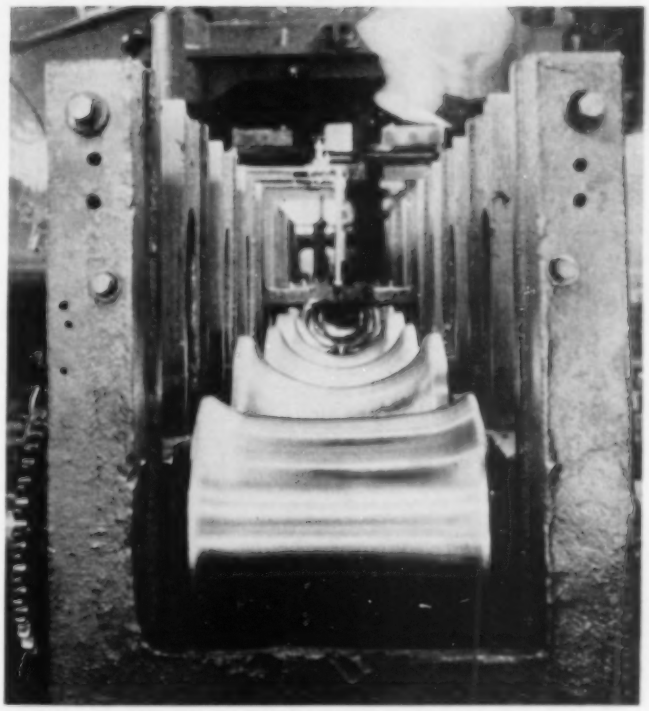


COLD-DRAWING

Both seamless and welded steel tubing is often cold-drawn to reduce wall thickness, to obtain greater dimensional accuracy, to improve exterior appearance, and to impart greater strength by working the metal. In this process the tube, with a supporting mandrel inside, is pulled through circular dies.







MAKING WELDED TUBING

The left side of the drawing explains how flat steel strip is progressively rolled into tubular shape, while the photograph shows the rolls that are used to do this. The right side of the sketch illustrates the welding process. The seam, at the top, is closed by simultaneously applying electric current to the edges and forcing them together by rolls that exert pressure against the sides and bottom of the tube.

resulted in a product of uniform quality. A large proportion of the welded tubing used in industry today is in the form of fabricated parts and is subjected to severe cold-forming operations such as expanding, beading, bending, flanging, and drawing. The fact that the weld area withstands these operations is proof that the physical properties of the base metal are preserved and are continuous throughout the tube wall.

As just mentioned, cold-drawing enters into the manufacture of welded tubes, although to a less extent than in the finishing of seamless tubes. But in both cases the process is substantially identical. In general, tubing is cold-drawn after hot-rolling in order to produce lighter walls and to secure a greater degree of accuracy in all dimensions than could possibly be obtained by hot-finishing. Cold-drawing also gives the exterior of the tubing a bright finish and imparts increased strength and stiffness through modification of the grain structure of the steel. The stiffness has to be relieved after each cold-draw pass by controlled annealing, which restores the normal grain structure.

Cold-drawing begins where hot-finishing ends—after the sizing mill in the case of seamless tubing and after the forming and welding operations in the case of welded tubing. The process itself consists in pulling the tubing through round dies by means of drawing tongs of tremendous power. First the tube is swaged, or pointed, at one end—that which starts it through the die. Next it is pickled in acid for removal of all traces of rolling-mill scale, washed, and dried. It is then treated inside and out with a liquid mixture of flour and tallow or other suitable lubricant. When this has dried, the tube is ready for drawing.

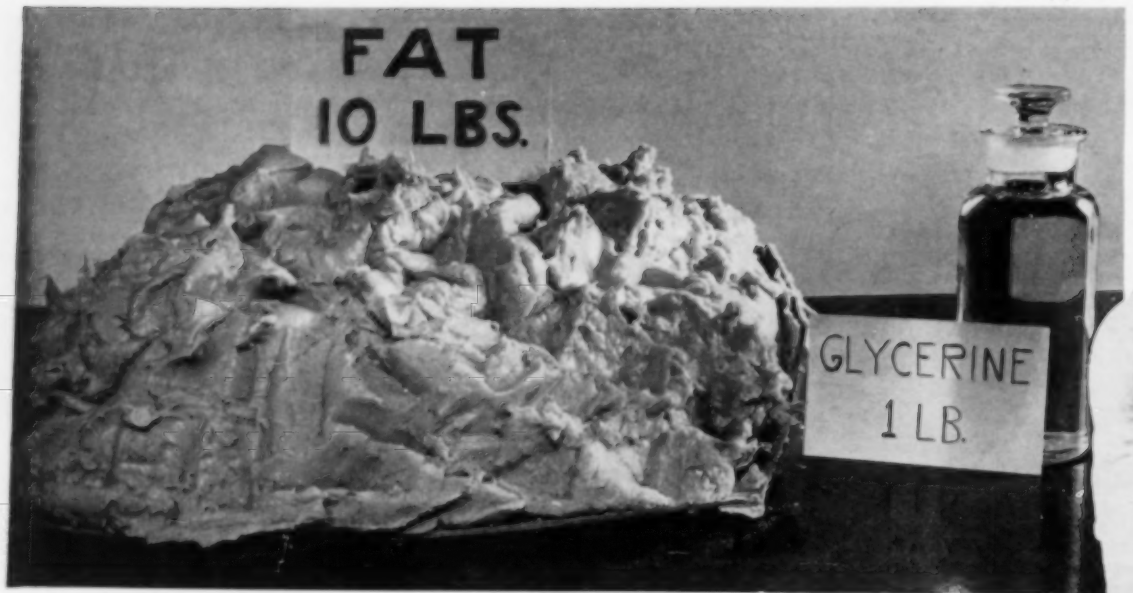
There are two chief methods of cold-drawing—the "pulling" and the "sinking" method. In pulling, the pointed end of the tube is pushed through the die and gripped on the other side by the drawing tongs. At the same time a mandrel, attached to the end of a long rod, is inserted into the tube from the open end all the way down to the die. When the tongs are attached to the endless chain of the drawbench and start pulling the tube through the die, the mandrel inside of the tube centers itself in the die opening and remains there until the entire tube is drawn over it. In this way wall thickness is closely controlled.

The sinking process, which is used for very heavy-walled tubing and for inside diameters of ½ inch or less, is practically the same as the pulling process, with the exception that no mandrel is required. Obviously, it does not permit altogether accurate control of wall thickness. In some cases, one cold-draw is sufficient to finish a tube to size, but usually it is necessary to give it two or even six to eight, sometimes as many as twenty passes through dies of decreasing diameters. After each pass the tube must be annealed, cleaned, lubricated, and dried.

It is difficult, if not impossible, to make a general comparison between seamless and welded tubing; it is somewhat like trying to compare beef with pork. When it comes to specific applications, the preference of one over the other is frequently, although not always, determined by the requirements to be met. One of the inherent merits of welded tubing is the uniformity of wall thickness. The flat strip can be held to close tolerances in thickness, resulting in concentricity of the outside diameter and inside diameter of the formed and welded tube. In many cases this saves machining and permits the use of minimum gauges. In rapidly rotating parts, concentricity serves to minimize vibration or whip in the member under load.

The welded tube has certain advantages in finish, especially where a smooth, polished surface is desired both inside and outside. Strip that is rolled from a rimmed ingot, for example, has the same dense-textured "skin" on both sides. Moreover, progress in the art of welding has reduced disturbance in the molecular structure of the steel in the weld zone to a minimum.

Seamless, too, has its inherent advantages. Inasmuch as it is pierced from solid steel, there can be no question as to the homogeneity and integrity of the wall structure of the entire tube. Significant in this respect is the practice of laying seamless pipe in river crossings even though all the overland line may be welded. Seamless tubing is not limited in chemical analysis to steel that will weld readily, nor to any relative wall thickness. In fact, it can be produced from steel of almost any desired analysis and in almost any diameter-to-thickness ratio. Also, it is practically an axiom in the steel industry that the more steel is worked, the more refined its structure becomes; and seamless tubing undergoes a number of such operations that are not applicable to welded tubing. It is apparent, therefore, that many factors such as service requirements, steel analysis, physical properties, and cost must be weighed in choosing between seamless and welded tubing for specific purposes.



Glycerine for War and Peace

Georgia Leffingwell and Milton A. Lesser

ALTHOUGH glycerine at the moment is best known as a war product, it has a multitude of peacetime uses. In fact, it is so valuable to industry generally that, as soon as the fighting is over, there will be a manufacturers' rush for what now goes into explosives, alkyd-resin paints, medical supplies, and other essential war materials. Glycerine is produced mainly in the process of saponifying fats and oils, and enters our daily lives through so many channels that only the principal ones can be described in this article. We consume it in the foods we eat, the clothes we wear—both textiles and leather, in the books and magazines we read. And science is steadily finding new applications.

In view of these wide and diversified uses, it is therefore hard to believe that the discovery of glycerine dates back only to about the time of the American Revolution. Although the history of this chemical is as romantic as that of any other, it was not discovered by some obscure chemist in some dark attic laboratory. It was first isolated in 1779 by the great Swedish chemist Carl Wilhelm Scheele, one of the leading scientists of his day, who contributed much to the basis of modern chemical knowledge. The story of glycerine is bright with the names of such outstanding men of science as Chevreul, Gay-Lussac, Berzelius, Liebig, Berthelot, Wurtz, and Pasteur. Nor can one forget Alfred Nobel, founder of the Nobel Prizes, who revealed that nitroglycerine could be rendered safer by absorbing it in suitable agents, thus making dynamite—now a necessity in peace as well as war.

Photo, Acme

The highly diverse applications of the clear, heavy, sirupy liquid stem from a unique combination of physical and chemical properties inherent in no other single chemical substance. It is because of these that we find it used widely as an humectant or hygroscopic agent, a vehicle, a solvent, a sweetening agent, an emollient, a reactive material, a lubricant, a softening and demulcent agent, a penetrant, an antifreeze, a heat-transmitting medium, a pressure-transmitting fluid, a refrigerant, an antiseptic and preservative, a suspending agent, and as a blending agent.

An important factor of glycerine's manifold qualities is that it can be used with entire safety in its varied field of application. Nonexplosive and nontoxic, it may be handled, applied, and

Photos, Newspictures

FROM FRYING PANS TO BATTLEFIELDS

The fat-saving campaign is moving many millions of pounds of grease annually from kitchens to processing plants where its glycerine content is extracted. Government spokesmen inform us that, on an average, only three weeks elapse between the delivery of fat to the family butcher and its conversion into powder and other essential glycerine-base war materials. Army camps are one of the leading sources of waste fats, their per-capita salvage running far ahead of the civilian figure.

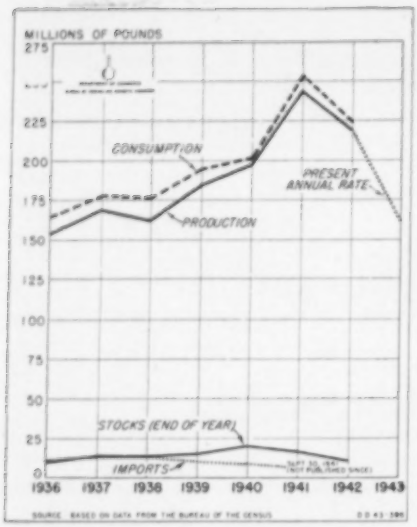
swallowed without harm. In foods, it is not an inert material serving merely as a solvent or vehicle. On the contrary, it is definitely nutritious, having a caloric value equivalent to that of carbohydrates. Indeed, glycerine is a normal constituent of the body, being liberated in the gastrointestinal tract as a result of the normal digestion of dietary fats and oils.

Decades of use in medicines have established the inherent beneficence of glycerine, and this was further corroborated by the extensive studies of the great physiologist Anton J. Carlson and his associates at the University of Chicago in 1933. Their experiments on both animals and humans settled once and for all the question of glycerine's suitability and wholesomeness for internal use. It is interesting to observe that it is one of the few solvents recognized by the Food and Drug Administration as being safe for edible products.

The 1943 production of glycerine in the United States is estimated at 150,000,000 pounds, and about nine-tenths of this comes from soap factories. Prewar applications, according to figures for 1940, were as follows, and are given in percentages: resins, including ester gum, alkyds, and others, 19.1; explosives, 15.8; tobacco, 13.8; miscellaneous, 11.6; transparent films—cellophane and sausage casings, 9.3; drugs, 8.5; exports, 7.7; cosmetics, etc., 2.9; printers' supplies, including rollers, 2.8; beverages, flavors, candy, gum, 2; paper, not including glassine and greaseproof, 1.8; adhesives, 1.4; margarine and other edibles, 1.2; rubber, 0.7; textiles, 0.7; leather, 0.3. These figures vary widely from those of the present day because of the war needs of the United Nations. Lend lease takes between 20 to 30 per cent of the current output; and of the glycerine remaining in this country, estimated allocations include 41.8 per cent for resins (chiefly for paints) and 23.4 for explosives.

Glycerine entered at an early stage into the production of synthetic resins, which have so markedly modified present standards of paints, varnishes, lacquers, and other quick-drying, protective coatings. It has often been said that ester gums, resulting from the interaction between glycerine and rosin, were the first synthetic resins to be used in formulating modern paint. While these ester gums are still important, present interest centers around the alkyd-resin group which is based upon the products of reaction between glycerine and phthalic anhydride or other polybasic acids. Variations in manufacture, modifications with suitable agents, and combinations with other synthetic resins permit the preparation of an almost infinite number of types of alkyds to meet many varied needs.

Alkyd resins are now employed not only for making protective coatings for wood, metal, glass, or other surfaces but likewise in the treatment of textiles, paper, and other fibrous materials. Their toughness, durability, and resistance have long been known, and have been recognized wherever American military equipment has gone. These resins are also finding other applications, a typical example being that in connec-



CRUDE-GLYCERINE STATISTICS

This chart, which was taken from the U. S. Department of Commerce publication "Domestic Commerce," shows that our production of glycerine has been declining since 1941, despite increased demands owing to the war. As consumption exceeded domestic output even in peacetime, the present situation has resulted in a shortage and governmental restrictions on the use of glycerine in many civilian products and processes. Although several substitutes have proved acceptable for certain purposes, none has the many properties that give glycerine its wide field of application. Interesting among the substitutes is apple sirup, which is being used by some manufacturers to treat cigarette tobacco. Production in 1943, mainly from off-grade apples that do not usually find a market, is estimated at from 15,000,000 to 20,000,000 pounds.

tion with the new emulsion paints which require only the addition of water. They are not widely used in the molding field; but as binding agents serve in making special insulating materials and foundry cores.

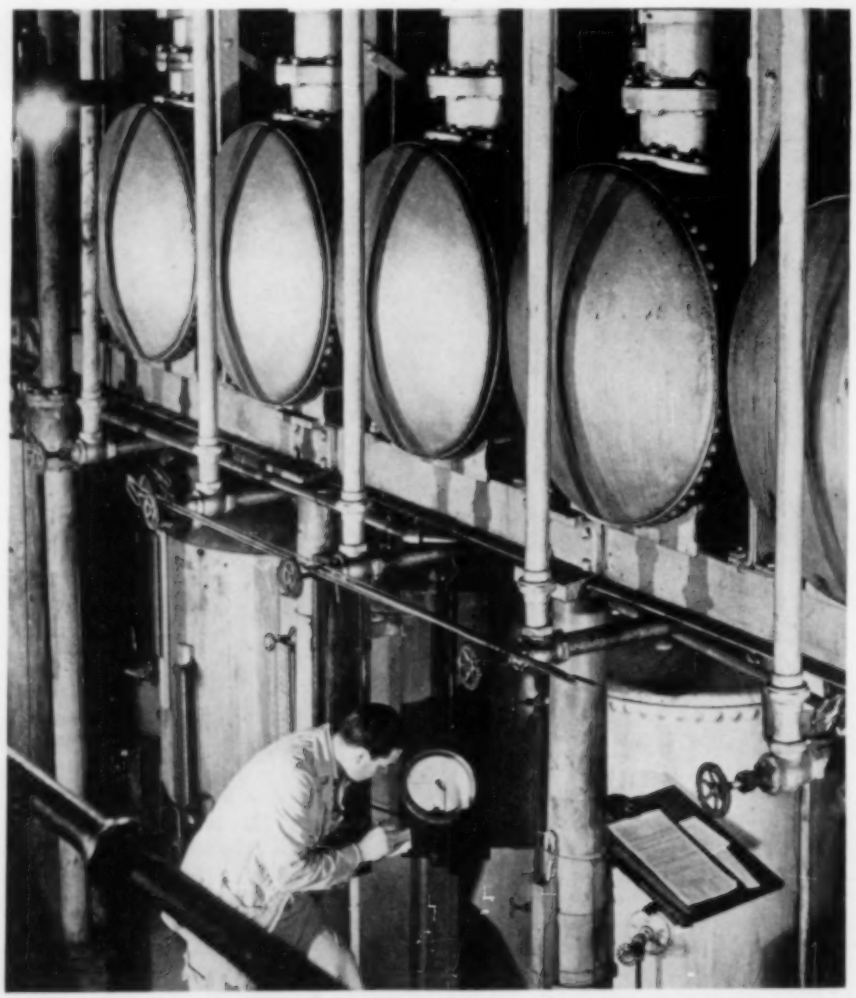
While nitroglycerine plays a major part in the production of modern war explosives, especially in propellants for projectiles, army maneuvers before our entry into the conflict stressed its importance in demolition work to harrass or delay the enemy, as well as in clearing damaged areas. But the peacetime needs of dynamite are equally vital to the life of the nation because of the service it performs in mining, in building roads, bridges, and airfields, in clearing land, and for other purposes too numerous to mention here.

Before wartime demands reduced the stock of glycerine available for normal domestic requirements, the tobacco industry consumed approximately 35,000,000 pounds annually for the purpose of keeping its products moist and fresh. As an ingredient of the "casing" mixture it serves to prevent drying and harshness and to disseminate the flavoring materials which help to make American cigarettes the most popular in the world.

No one needs to be told how the introduction of cellophane revolutionized the packaging industry, nor what it did to the sales appeal of numerous items. But without a suitable plasticizing agent such as glycerine to maintain its flexibility and strength it would be brittle and useless. Today, cellophane has taken on new duties, because it has been learned that glycerine-plasticized cellulosic materials are highly impervious to war gases, especially mustard gas. It has therefore become a major packaging material for foodstuffs for our armed forces. But the most durable cellophane of all goes into the production of capes for army personnel as a protection against all vesicant gases, including lewisite. There are indications that industry may avail itself of the material for the purpose of safeguarding workers against industrial skin diseases.

Glycerine has many applications in food processing. One of its most important uses in this field is in the manufacture of flavoring compositions, serving not only as a solvent for the taste-appeal products but also to thoroughly disseminate them in the food or beverage. For years it has been employed as a means of keeping baked goods, candies, jellies, preserved fruits, cocoanut, and many other edible products fresh for longer periods than they could be without this ingredient. It is an essential aid in making sausage casings, and enters into meat-preserving coatings of various kinds, as well as into preservative compounds for still other foods. As a natural product of fermentation, and therefore present in all wines, beers and ales, the chemical has enjoyed favor as a bodying and smoothing agent for all sorts of liquors. During recent years, glycerine and glycerine-containing compositions have assumed an important role as direct immersant refrigerants in quick-freezing food processes.

It is no exaggeration to say that the

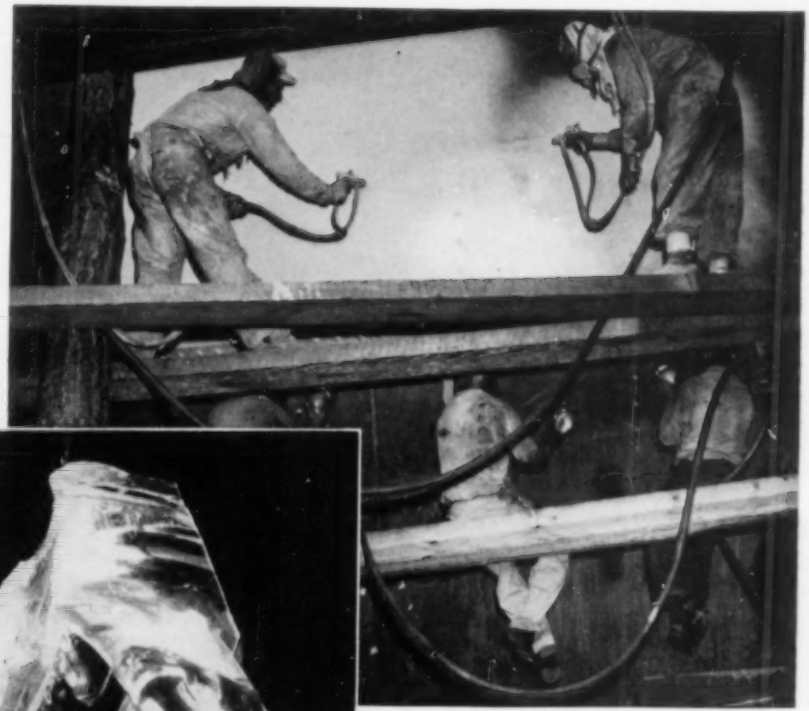


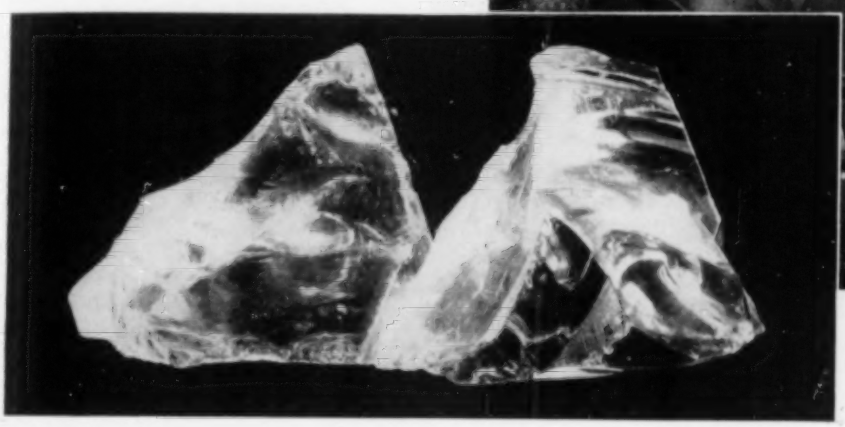
REFINING CRUDE GLYCERINE

When animal or vegetable fat is treated with an alkali, such as caustic soda, soap and soap lye are formed. The latter contains from 3 to 5 per cent of glycerine. By concentrating the lye by boiling under a vacuum the glycerine content is increased to around 80 per cent. This is known to the trade as crude glycerine, which is purified by distilling it in apparatus such as that shown. To be satisfactory for war uses, the chemical must be at least 98.6 per cent pure.

GLYCERINE-BASE PAINT

The greatest single prewar use of glycerine was the making of synthetic resins for the manufacture of quick-drying paints, lacquers, etc. Today alkyd resins (below) are of importance not only for this purpose but also in the textile, paper, and other industries. At the present time glycerine-base paint is serving almost exclusively as a protective coating for our ships, planes, tanks, jeeps, and trucks. The picture at the right shows workmen at the United States Steel Company's Federal shipyard painting a war vessel with the aid of air-operated spray guns.





Photo, Newspictures

chemical is a highly useful member of the medical armamentarium. Its rating in prescription surveys proves that its emollient, demulcent, solvent, sweetening, hygroscopic, and other properties are fully appreciated. It is a standard ingredient of ointments, pastes, lotions, linaments, etc. for skin disorders and other external affections, as well as of burn preparations, including tannic-acid jellies. In fact, one group of products is named "Glycerites," indicating that glycerine plays an important part in compounding them. Furthermore, tests have shown it to be one of the most valuable vehicles for applying the sulphonamide drugs.

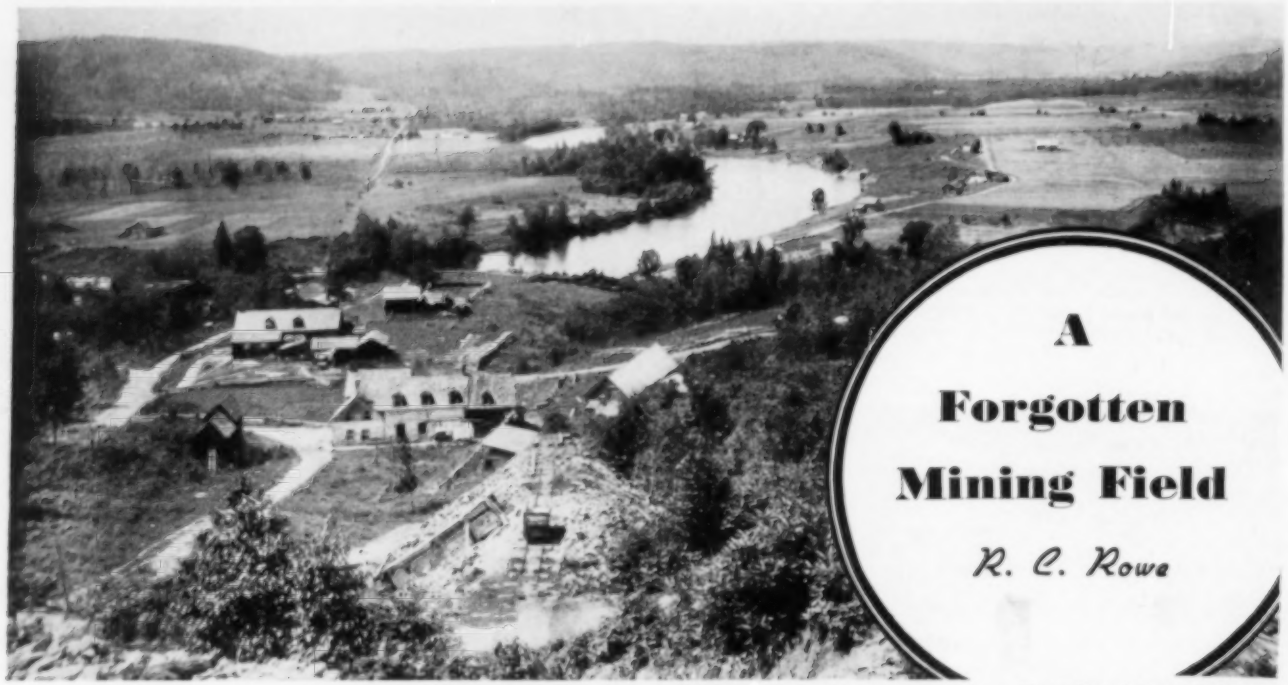
An excellent solvent and vehicle for antiseptics, glycerine has found extensive use in the treatment of many types of wounds and as an ingredient in wound dressings and bandages. Its preservative as well as solvent properties are taken advantage of in making rabies, smallpox, and other vaccines. It is an agent in preparations for allergic diseases such as hay fever and asthma. For internal medication, the sirupy fluid serves as a vehicle, solvent, and sweetening for a host of remedies given by mouth. It is a massing agent in compounding pills and tablets, and an essential constituent of capsules. In the branches of dentistry, veterinary medicine, and chiropody, it renders equally useful service.

Cosmetics manufacturers know that glycerine is one of their most valuable raw materials because it enters into the formulation of so many of their products. In vanishing and greaseless creams, antiperspirants, lotions of all kinds, liquid make-up, and numerous other items for the fastidious woman it is a necessary ingredient. In the printing field it is not only an essential component of many inks but, together with gelatin, also of rollers. The textile industry uses large quantities as a lubricating agent, in the manufacture of synthetic fibers such as rayon, as an admixture in printing pastes and dyeing compositions, and in other capacities.

The paper industry applies glycerine widely in the making of glassine, parchment, and similar papers, as well as in the finishes and treatment of other specialized papers. The incorporation of a small amount is standard procedure in the manufacture of tissues and the like where softness is a prerequisite. Its inclusion helps to offset curling, "dishing," and other characteristics that interfere with good printing. The chemical is to be found in adhesives that are used to bind books and magazines, as well as in nearly all pastes, mucilages, and glues. In these it serves to control flexibility, and by its hygroscopic action prevents excessive drying that would result in loss of bonding power. It is because of these qualities that glycerine enters into the making of cork liners for bottles, bottle caps, and refrigerators, as well as of gaskets and other types of packing where long life is essential.

The term "miscellaneous" covers a multitude of other applications. To mention only a few, there is the leather industry, which uses glycerine in the "fat-liquoring" processes and in the dyes and polishes for leather goods. In the field of lubrication it serves excellent purposes in low-temperature work and under conditions where fire hazards exist. It meets a need where an organic solvent-resistant lubricant is required; and in oiling food-mixing equipment its edibility is of first consideration. As a pressure-transmitting agent it renders valuable service not only in hydraulic pumps, brakes, and door checks but also in the recoil mechanisms of big artillery pieces and aircraft landing gear. The antifreeze properties of glycerine solutions, long familiar to automobile owners, are taken advantage of in deicing mechanisms for airplane wings and in the sprinkler systems of unheated warehouses. Because glycerine-gelatin combinations are only slightly pervious to gases they have often been utilized to make repairs in gas tanks. One typical mixture for such sealing purposes consists of a nondrying substance made from equal parts of glycerine, gelatin, and sugar dissolved in just enough warm water to form a thick, firm jelly when set.

In this panoramic view of glycerine in a modern world, an attempt has been made to high light some of the more outstanding uses of this truly versatile fluid. Today it is in the forefront as a war essential, but let it not be forgotten that it is a requisite in thousands of products and applications that contribute to health, comfort, beauty, and culture.



A Forgotten Mining Field

R. C. Rowe

Photo, Geologic Survey of Canada

BOOM COUNTRY

Panorama of the Lievre River region around Buckingham, in the Province of Quebec, Canada. In the foreground is the Emerald Mine, one of the numerous apetite workings that flourished there in the eighties. With the opening up of great phosphate beds in the southern part of the United States the industry declined, and it has never been revived.

UP TO the discovery of Cobalt in the early part of the twentieth century, Canada's mining history presents a spectacle of what might be called spasms of activity in various parts of the country. Most of these have received attention from chroniclers (among them the author) in varying degree; but it is a somewhat remarkable fact that one of the most important of the very early bursts of activity has been virtually ignored by modern reviewers. We refer to the phosphate mining industry which flourished for twenty years from 1872 onward.

The fact that such a development should have received so little notice is all the more astonishing when it is remembered that it took place in a well-settled area, practically at the doorstep of the City of Ottawa and only about 100 miles from Montreal; that it was an operation that employed several thousand men at its productive peak; that in one sense it was the birthplace of extensive hard-rock mining in Canada; and that it had a very definite effect, through its personnel and the attention it focused on the Dominion, upon subsequent mining history.

The Canadian phosphate-mining industry was based upon the town of Buckingham lying roughly 20 miles east of Ottawa, and most of the mines were situated close to the Lievre River which was utilized for transportation purposes. Phosphate existed in this district as apatite, which is calcium phosphate in its purest form of natural occurrence. It is usually green, but can also be brown, yellow, gray, red, violet, white, or colorless. Like all phosphates, its main use lies in the manufacture of fertilizers, but it is also a source of phosphorus.

Before passing to the historical aspects of apatite mining in the Lievre River district some brief observations on its geological features are in order. The area under review lies in the southern fringe of the hilly region known as the Laurentians. It is a country of rugged, rounded hills characterized by a large number of lakes and deep gullies with fast-flowing creeks. Running roughly north and south are two major rivers, the Lievre and the Gatineau, both of which have their headwaters far to the north and discharge within 18 miles of each other into the mighty Ottawa. The apatite belt lies between these two rivers and extends for a short distance east of the Lievre, the southern edge being about 20 miles north of Buckingham.

The geology of the district is typical of the great region that lies north of the Ottawa River and is extraordinarily complex, a lack of conformity rendering discussion of it decidedly difficult. By far the greater proportion of the rocks are gneisses of various types, though large areas that are unmistakably of normal granitic character are encountered. The gneisses are a complicated mixture of igneous rocks and highly altered sedimentaries. Through this mixture are bands, or zones, of a distinctly calcareous nature. These often take the form of highly impure crystalline limestones, which are readily distinguishable. In other instances the limestones have been so altered that they are almost indistinguishable, except for their perceptibly calcareous nature, from the igneous rocks that have acquired gneissose structure.

Therefore we find a system of granite gneisses, calcareous gneisses, and crystalline limestones that is extremely lacking in uniformity and that is twisted and distorted in a most puzzling manner. Cutting through this there is, further, a system of pegmatites. These are scattered in great profusion, sometimes in the form of well-defined dikes ranging from a few inches to hundreds of feet in width, and sometimes in apparently disconnected "splashes" which frequently cover large areas. In addition, there are many pyroxenite dikes. These are confined largely to the apatite belt, although scattered occurrences can be noted throughout the district. They are evidently of earlier origin than the pegmatites, as there are places where they have been intersected by the latter. Numerous diabase dikes cut the whole system in various directions.

The apatite exists in association with the pyroxene, and an associated mineral is phlogopite mica. The deposits are irregular in shape and size and appear to have been found entirely within the

pyroxene in proximity to the contact with the gneiss. The general irregularity of the beds themselves naturally presented mining and development difficulties and also rendered economic assessment of the many properties an impossibility. Numerous theories were advanced as to the origin of the deposits, and such men as Adams and Ingalls studied them very thoroughly in the seventies and eighties. However, so far as the writer can determine, the theory of deposition in relation to structure was never clearly established, and the search for new beds in mining operations was therefore largely a haphazard affair relying upon experience and that intangible quality known as "a nose for ore."

The actual discovery of the mineral in the region dates back to 1829 when Lieutenant Ingalls noted its presence; but it was not until 1871 that operations really began. Previous to that date some apatite had been mined in Ontario, and in 1862 a pamphlet was distributed at the London Exhibition which mentioned apatite mining near Port Elmsley. This point is mentioned to show that a definite demand for the mineral existed, and this doubtless was the influence that started the activity on the Lievre River. It would serve little purpose at this late date to establish who the first operators were. Their names seem to be lost; but we do know that in 1871 a small quantity of phosphate was shipped from the area. By 1874 this had grown to some 300 or 400 tons; and by 1877, when nearly 3000 tons were shipped, the industry was becoming well established.

At that time the Buckingham Mining Company, made up largely of Ottawa interests, was the main operator. A good deal of prospecting was going on, and the whole area was progressing toward the stage of violent development and promotion which characterized the phosphate boom. In 1878, production more than trebled; in 1882 it reached 16,585 tons and climbed steadily until 1885 when the peak output totaled 28,535 tons. About twelve companies were producing, and many were engaged in prospecting and development.

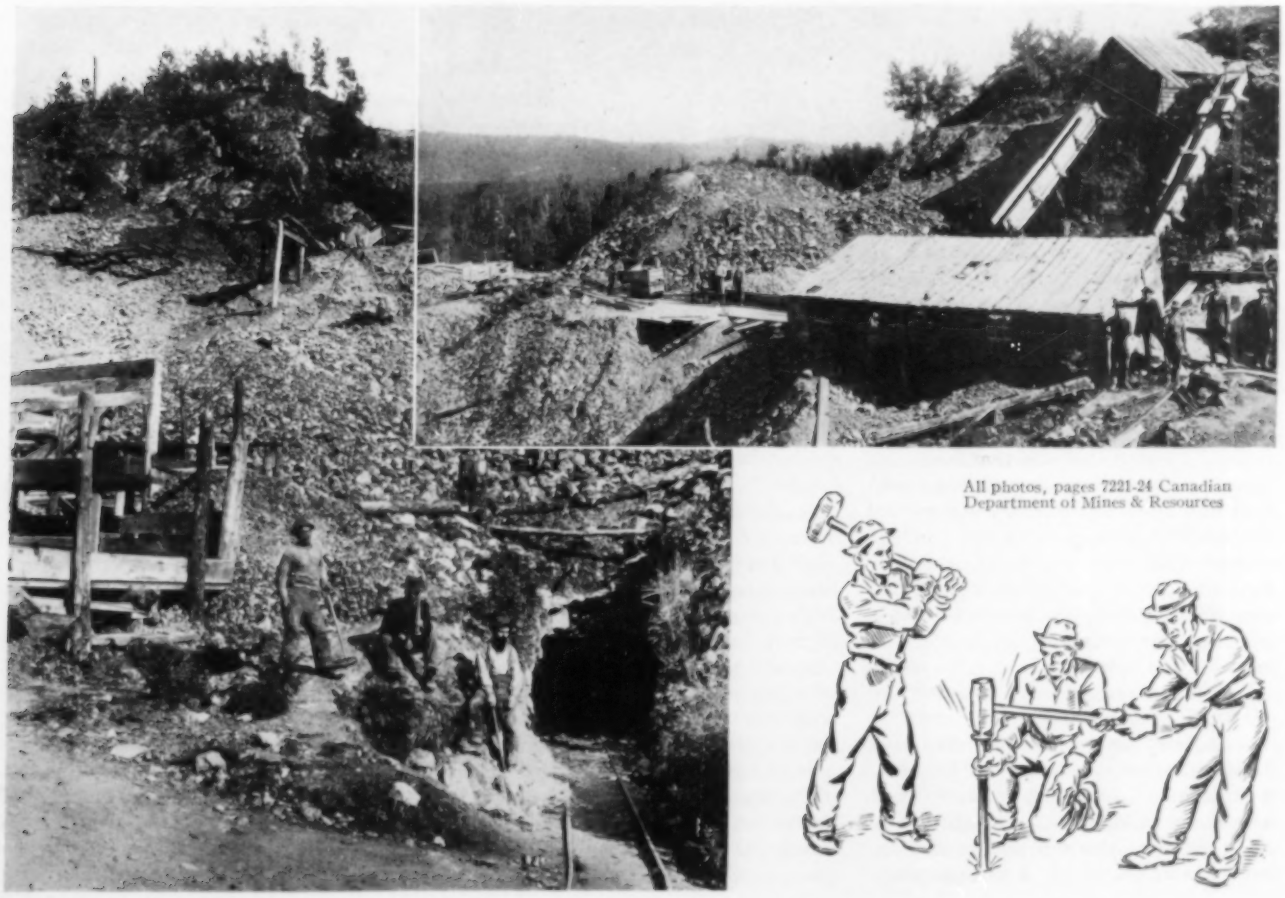
Considerable British capital was invested in the region, which had by that time excited a lot of attention in England. This was natural enough, because almost all the output was shipped to that country. The whole area was in a fever of activity, and was something of a harbinger of the days to come when Canadian mining would sweep northward. During the days of the phosphate boom, and for some years following, there was a brisk trade in property options and mining rights, and promoters reaped a harvest. The foundations of some Canadian fortunes were started in those riotous years, and the pattern of things to come was truly laid.

The names of the mines ring down through the years with a lilt and a song, and in them was all the imagination of a sound and virile nation. There was the North Star, the Emerald, the Squaw Hill, the Union and High Rock, the Aetna and Tamo Lake, the Little Rapids, the Crown Hill, and the London. They were the product of fancy, and born of high hope. Naturally, the workings attracted men from far and wide—from Nova Scotia, the United States, and from Britain. The valley of the Lievre River was long before settled by hardy pioneer farmers who were famous loggers and river drivers. Many of these turned to mining, in which they became remarkably proficient, and of them we shall have more to say later.

The Lievre River was white-pine country, and Buckingham was famous as a lumbering center. Its wooden side-

EMERALD MINE

At the right is a view of the cobbing house from which the crude phosphate was trammed to the Lievre River and transported by barges to rail head at Buckingham. In the other picture is a typical drilling crew, consisting of two hammermen and a twister who held the steel while the drillers struck it alternately with 8-pound hammers.



All photos, pages 7221-24 Canadian Department of Mines & Resources

CROWN HILL MINE

Mining was done by opening up surface showings and following them down by way of shafts sometimes as much as 600 feet deep. Note the women in the bucket that gave access to the pit. We are told that it was the practice to take them down Sundays to see the workings.

walks were pitted and splintered by the calked boots of loggers and river drivers, and it bore a reputation as a place of lusty men. In the roaring eighties of the phosphate boom a few thousand miners were added to this hardy community, and it can be easily imagined that it was a stirring place where men learned to attend strictly to their own business and where, on Saturday nights, there were probably more fights to the square foot than any place before or since.

Apatite mining was carried out almost entirely by open-pit methods. Boiled down to fundamentals, they consisted of opening up a surface showing of the mineral and following it down. In the earlier days, drilling was done entirely by hand; and in breaking the hundreds of thousands of tons of hard rock was produced the world's finest bunch of hand drillers. The picturesque art of hand drilling has almost passed from the mining scene. For this reason, and as a slight tribute to the men who excavated vast footages through the exercise of their muscles, some account of it is given here. There were three men to a drilling crew—two hammermen and a twister. The latter handled the steel, lifting and twisting the drill after each blow. Hammermen used 8 pound sledges with long handles. They struck alternate blows. In action, the handle was swung back over the shoulder until it lay practically flat along the worker's back. It was then brought forward with a swing, the man bending his back with the downward stroke of the hammer. The grace and proficiency these crews attained is almost beyond belief. Timing and coordination of the various movements of the three men was of almost uncanny and machinelike precision. The symmetry of motion was perfect, the balance was superb, and the muscle play of those swinging arms and swaying bodies was an unforgetable sight. The precision of the blows was revealed by the fact that the head of a steel showed a brightened spot that was no larger than a dime at the point of impact, and the perfection of timing was sometimes demonstrated by what seemed a foolhardy trick on the part of the twister, who, in his pride, would pass his thumb over the head of the steel between the regular rhythm of the hammer blows.

The periods of hammering were governed by the rock and to some extent by the skill of the twister. When twisting became sticky through the accumulation of drill cuttings, he would call "mud," and the hammermen would take a breather while he "swabbed" out the drill hole. The pride of these men in their work was shown by the care they took of their hammers. In many cases they made their own handles from well-seasoned hickory, and it was a common sight to see them outside the bunkhouses evenings shaping and scraping handles, or to meet them in the woods searching for suitable trees from which to cut the rough shapes which were then hung for seasoning.

Broken rock was loaded into either buckets or trays and hoisted with derricks. Sorting for obvious waste was done during mucking. Phosphate rock was sorted and cobbed at the surface, and the crude apatite was hauled to the Lievre River where it was loaded on barges and taken to the railway at Buckingham for shipment. Later, shafts were sunk and underground mining was carried on. Mechanization was adopted, and steam drilling was used extensively. A more scientific and technical trend began to manifest itself; but by that time events in other parts of the world had already started to cast their shadow over the busy scene.

Down in Florida and in other southern states were being exploited great beds of sedimentary phosphate that could be worked by large-scale methods such as power shoveling and dredging. These were not of the same high quality as those in Canada, neither did they present the same irregularity of occurrence and high-cost mining. At first they were a threat, conveniently ignored by the optimists of the Lievre River. To their minds it seemed incredible that this thriving industry could be menaced by bones of marine organisms buried in Florida swamps, and so promotion went on and production held high as the nineties were ushered in.

But the inevitable was happening. Florida phosphate was moving out of its native swamps in an ever-increasing flood. Exports to the United States, which had been a feature of the closing years of the eighties, dried up. For a short time the influence of British finance, heavily interested in the Canadian apatite, held back the inexorable march of economic events; but by 1890 the industry was in a bad way. Prices had dropped, and even the most optimis-

tic operators on the Lievre River were so uncertain that the editor of the *Canadian Mining Review* was moved to stiffen their waning confidence in a review of apatite mining in the March 1890 issue. In the course of his remarks he had this to say, "We do not hesitate to counsel those who have interests in our apatite deposits to preserve their courage and await further developments with confidence and composure." These were brave words written by a man of superior judgment without an ax to grind; but he was wrong. The apatite mining industry of the Lievre River was dying. It still took a few years to bring the final end, but the sweeping tide of events was already writing "finis" to a colorful episode in Canadian mining history. After 1892, production took a nose dive, and by 1894 it had practically ceased. It is worth noting that this was only nine years before the great silver camp of Cobalt was discovered.

At the time of the decline there was no sign of depletion of the deposits. The greatest mining depth attained was 600 feet at the North Star, and old reports indicate that the bottom of the workings are still in apatite. The same condition seems to be true at most of the mines, and it is highly probable that a large amount of the mineral remains, awaiting the day when economic conditions will again render its extraction profitable.

There is no doubt that general efficiency in the district, particularly in the earlier days, was very low. There appears to have been a great deal of loose management, and methods were primitive. The gaping holes and scars in the hills bear witness to this fact, and enormous quantities of waste rock were handled to obtain a relatively small quantity of apatite. The nature of the deposits and their lack of continuity made high mining costs inevitable; but these, had the field survived a few years longer, might have been substantially lowered through the acquirement of knowledge regarding the behavior of the deposits. As things were, the operators worked through a lense, and then followed stringers until they found another lense. A clearer conception of the structural geology and the use of diamond drills might have saved a lot of costly and dead work. Not until the region had entered upon its decline was diamond drilling resorted to, and even then it seems to have been used at but one property.

So far as actual costs are concerned, it is difficult to arrive at figures. In fact, there is some reason to suspect that the operators themselves were not too certain as to that question. Records were apparently woefully incomplete, and certainly were not broken down. At a meeting of mining associations in Montreal in 1893, Captain Adams remarked that the cost of mining apatite might range from 50 cents to $1000 per ton. The gentleman was not being facetious—he was merely stressing the irregularity and uncertainty of the deposits. J. Burley Smith, a well-known mining engineer who was manager of one of the properties, gave a figure of $7.20 per ton laid down at railway, including development costs. However, he rather ruined this specific statement by qualifying it with the remark that "it may cost $10, $15, or $20, or even $30 a ton."

ALLAN'S MINE

This picture gives an excellent idea of the size of the open pits that were sunk in the apatite deposits in the Lievre River region. The irregularity of the beds and the highly complex nature of the geology of the area made operations not only difficult but also costly.

In 1876, Henry G. Vennor gave a detailed figure of $13 per ton laid down in England; but even here there is a lack of clarity, for the Buckingham Mining Company reported the cost of mining to be from $4 to $5 per ton. Whether or not this figure included development charges was not stated. Therefore, we do not know much about it; but it does seem fairly clear that no one made much money out of operating, though some nice fortunes were made in selling properties and in promoting. There is an interesting field for speculation anent the question as to whether or not it would be possible to work these potentially valuable deposits profitably with modern methods, scientific management, and careful study. No serious effort has been made to revive the industry since its decline 50 years ago, and it is probable that no major mining operation has been so completely forgotten.

There is no doubt about the economic value of the apatite mining of the eighties to Canada. It brought a lot of money into the country, and it liquidated a natural resource at a time in her history when new wealth was badly needed. These are concrete and assessable values. But it is a favorite theory of this author that the more intangible results of the boom were of even greater worth to the Dominion. In the first place, it attracted a great deal of attention to Canada as a mineral region; the deposits were described in the technical press of the world; and the district itself was visited by

PANORAMIC VIEW

The High Rock, one of the numerous isolated mines in the Buckingham area. The property was aptly named. From the workings, the phosphate rock was delivered by cable tramway to the cobbing house below.

mining men from many countries. Secondly, it resulted in the development in the area of other minerals such as graphite, mica, and feldspar, the production of which continued long after the apatite mines had closed and trees were growing on waste dumps. In fact, mica and feldspar are still being obtained from the region. Thirdly, and perhaps more important, the apatite boom bred a race of miners who have left their mark on all parts of this country.

The hardy pioneer farmers, who with the passing of the great white-pine forests turned from logging and river driving to mining as naturally as a duck turns to water, became highly proficient in their new craft. Just as they and their fathers had followed the receding forests, so they followed mining as the activity in the phosphate area subsided. They went to the Klondike in numbers; and when the silver and gold discoveries of northern Ontario electrified the world, they flocked there in the most natural order of things. Fred LaRose, who is usually credited with being the first to find silver in Cobalt, had worked in the apatite mines of the Lievre River. Tom Garvey, who discovered the main silver veins of the Castle Trethewey Mine at Gowganda, was a Buckingham man. Their names flit through the colorful story of the early days of the North like fireflies through the gloom of a summer's night. It would take too long to chronicle them, and in any case most of them are but memories now. But these pioneers did great things in the new mineral empire of the Canadian north. They brought to the new camps their unbeatable experience in hand mining and their knowledge of hard rock, thus providing a steady stream of experienced mine labor.

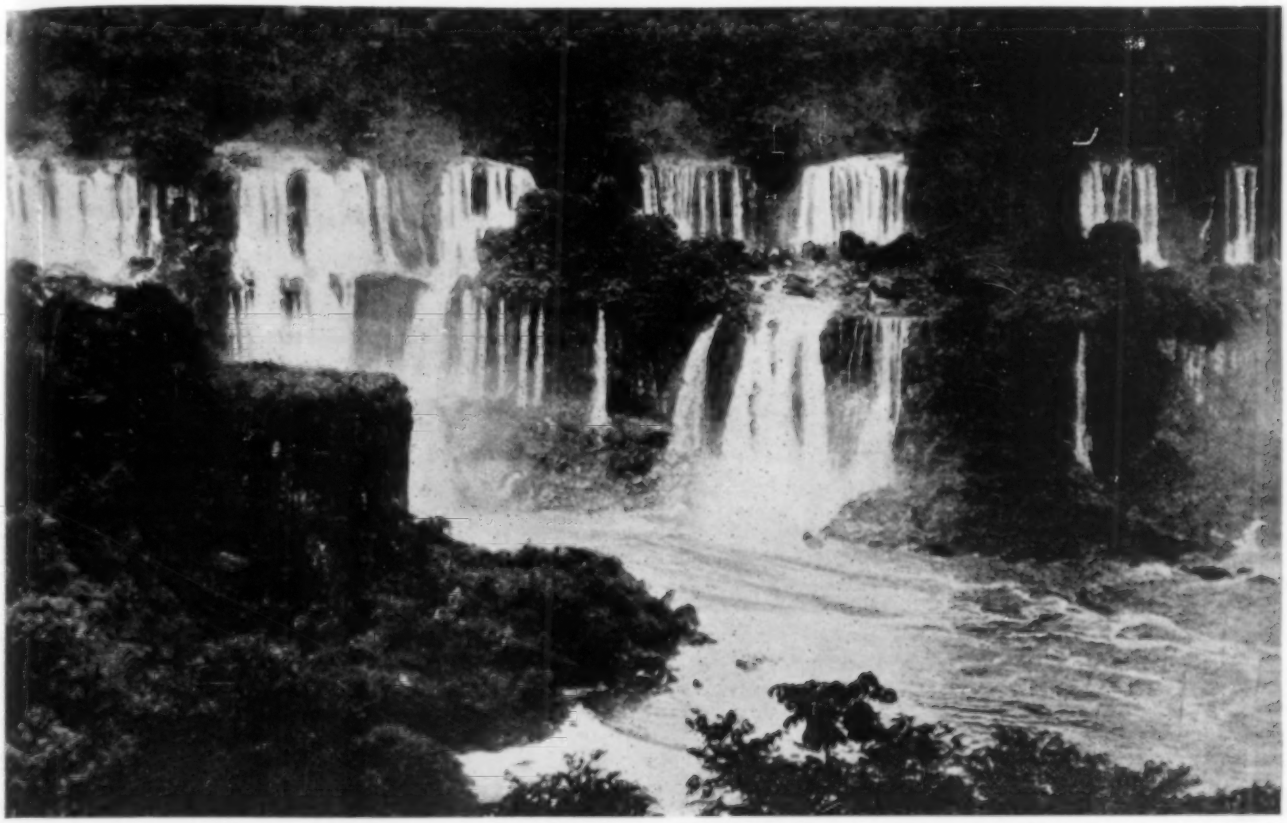
Apart from the race of miners, the phosphate industry produced some other names that played a part in our mining development. One of them was George R. Smith, who left the management of an apatite mine to work for the Ingersoll Drill Company. In 1892 he was appointed manager of the Bell Asbestos Company at Thetford and installed the first mill for the extraction of asbestos fiber. The Bell Asbestos Mine is now run by his son, O. C. Smith. Thus for more than 50 years the management of this property has remained in one family. J. Burley Smith, one of the most picturesque figures among the apatite mine managers, also worked for the Ingersoll Drill Company in England and developed one of the early-type coal-cutting machines. So we find the history of one of the greatest mining-machinery manufacturing companies intimately entwined with the story of this little-remembered incident in the mining history of Canada.

Today one can drive up the Lievre River valley and, if the mood is there, leave the main highway and walk up old, barely distinguishable roads to those old mines. The great pits and the huge waste dumps are mute evidence of the activity that once stirred this now quiet countryside. Nothing is left but the holes. Buildings have long since gone, and trees grow where cobbing sheds, bunkhouses, and other structures formerly stood. But the walls of the open cuts have in many cases stood up surprisingly well, and in them there are still to be seen the marks of the drill holes made by the gangs of hardy hammermen.

There was a braveness and a dash about the apatite boom that is mostly legend now, but symbolical of it in some weird way are the words spoken to this writer by an old Irishman who, in his young days, was a sort of batman to J. Burley Smith, a great bearded man with a lusty love of life. In addition to being a well-known mining engineer he was a great horseman and drove a four-in-hand. "Ah," said the old Irishman, "I mind many's the time we would come drivin' down from the Squaw Hill, going like a bat out o'hell. Him up in front of the rig handlin' the lines of them four horses, wid his great beard blowin' to each side of the face of him like the wings of an eagle, and me hangin' on behint wid me eyelids and a prayer in me heart that we reach the bottom safe." They always did, because the old Irishman lived to tell the tale, and J. Burley Smith died at a ripe old age some years ago. They and their kind laid a foundation truly and well and produced a breed of men that has served Canada and her mining industry with a distinction that shall long be remembered.

SORTING

A gang of cobbers at work at Walker's Mine. Note the variety of containers in which they put the crude apatite. A hammerman is standing in the background.



Photos, Coordinator of Inter American Affairs

FUTURE SOURCE OF POWER

This picture shows the Sete Quedas or Seven Falls at a point in the River Parana where it forms the border between Brazil and Paraguay. These falling waters, like many others in South America, constitute a potential source of electric power that will help to open up some of the vast undeveloped regions in our neighor republics.

Postwar Electrification in South America

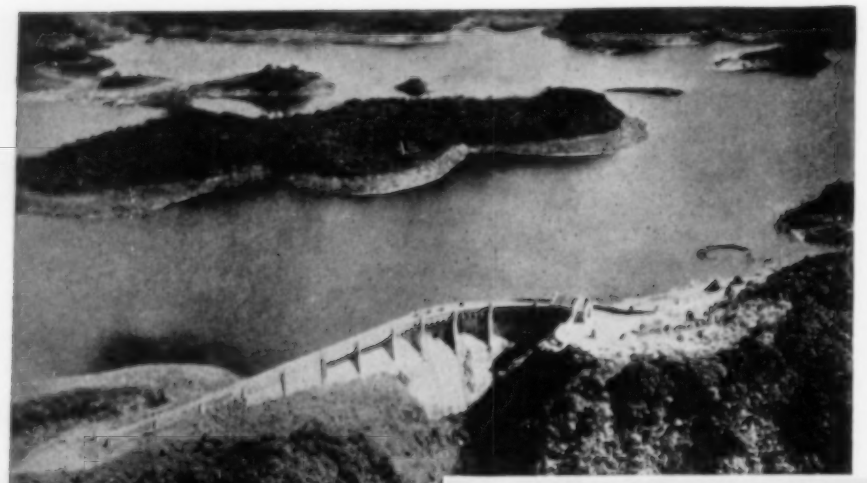
Charles A. Howard

THE continent of South America, while exceptionally well endowed with mineral resources of great value, has limited commercial deposits of coal, and most of those are insufficient in quantity, poor in quality, and badly located in relation to consuming centers. Increasing industrial expansion necessitates importing large amounts of fuel, and this is placing a heavy burden on the economies and finances of most South American nations. It is therefore not surprising that many of the republics are taking stock of their potential power resources and stimulating interest in long-range electrification programs. So far as the actual work of development is concerned, that is at present retarded because of wartime restrictions on ocean shipping; and only those projects that are essential to civilian needs and to the production of strategic materials are assured priority on equipment.

In Central America, as in South America, there are sites for possible hydroelectric installations, as, for example, the Lempa River region in El Salvador. But as the power requirements of most of the Central Americas are relatively small, and as the initial cost of hydroelectric plants and transmission lines is relatively high, the utilization of this potential energy will probably await the fuller industrialization of these republics. Mexico has many power sites, but most of them are remote from centers of population. However, the country is blessed with an abundance of oil for fuel and has not been under the same pressure as some of the other republics to harness its falling waters. Mexico's National Electrical Commission now has a large hydroelectric project under construction at Ixtanpantongo in the municipality of Valle de Bravo, about 100 miles west of Mexico City. The first of three 38,000-hp. generators is now about to be installed there.

Both Uruguay and Chile have nationalized the future production of electric power within their borders and have drawn up plans for the complete electrification of their public services, industries, and railroads. Although Uruguay is not a mountain republic, its electrification program is one of the most advanced in South America. Uruguay is fortunate in having a large source of waterpower in the middle of the republic and only 150 miles from Montevideo. Work on a 3800-foot dam across the Rio Negro was begun there in 1937. But as the original European contractor could not finish the job because of the war, it was turned over to a firm in the United States. One 32,000-kw. turbine generator will soon be set up at the dam and a transmission line run to Montevideo, thus relieving that city of some of its dependence upon imported fuels.

The total cost of the Rio Negro project, including four generators and the transmission line, is reported to be approximately $35,000,000. Several other waterpower and irrigation projects are included in the long-range plans of Uruguay. These are: a dam on the Queguay River just north of the city of Paysandu



HARNESSED WATERS

Two of Brazil's hydroelectric developments that are mainly concentrated in the great industrial states of Sao Paulo and Rio de Janeiro. Both serve Sao Paulo, the second largest city numbering 1,318,000, or 10 per cent of the republic's entire population. The pictures show the Lages Power Plant (below) and a vast lake formed by Rio Pedras Dam.

to develop 8000 kw.; another on the Arroyo Cunapiru in the northern section of the republic, 10,000 kw.; and a third on the Cebollati River in the eastern part to generate 11,000 kw.

According to the plans of the Chilean Development Corporation, Chile's principal centers of potential hydroelectric energy are in the Aconcagua region lying north of Santiago; in the Rancagua region along the Rapel River just south of the capital; and in the Orsorno region, which includes the chain of lakes in the south where the rainfall exceeds 100 inches annually. While the rivers are not large, they plunge from great heights to the sea and offer sites for high-head installations, and some of the lakes are well situated for power development. Furthermore, the waterways in southern Chile provide many locations for chemical plants, smelters, and other large consumers of cheap power.

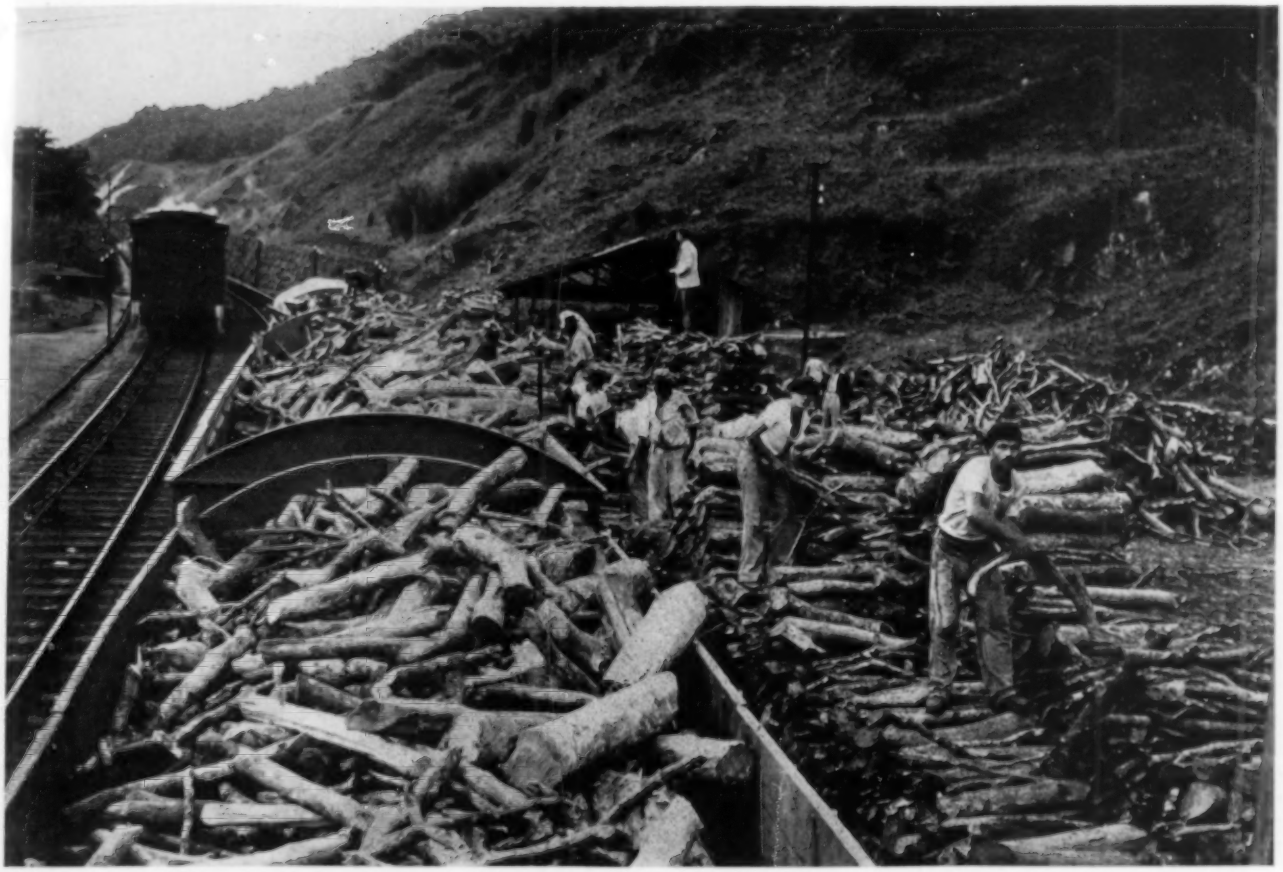
The Aconcagua system will be used largely in the production of Portland cement and, together with other power stations, will contribute to the electrification of the railroads and supply new industries with current. At the present accelerated rate of consumption it is estimated that the country will need 600,000 tons of cement by 1945, or nearly double the 1939 output. Chilean interests have purchased two unused cement plants in the United States. These are to be dismantled for shipment and set up in the vicinity of Coquimbo.

Included among the hydroelectric projects now in various stages of survey and construction in Chile are the Ralun generating plant that will draw upon the waters of Lake Todos los Santos and produce 50,000 kw. of initial power and at least 126,000 when fully developed; the Manio plant on the San Pedro River with an initial 50,000 kw. and a potential ultimate production of 125,000; the Abanico plant on the River Laja with an immediate output of 40,000 kw. and a final capacity of 100,000; and the Rapel plant, on the river of the same name, with an initial capacity ranging from 60,000 to 120,000 kw. The latter will cost 900,000,000 pesos, and in all probability will be the largest of its kind in South America. Part of the energy developed will be used for electrifying the state railways.

Bolivia, one of the South American mountain republics, has large reserves of hydroelectric power. It is estimated that Lake Titicaca alone can produce 700,000 kw., which is more than is now generated at Boulder Dam. However, there is no market for such a block of power in Bolivia at the present time.

Colombia now has a total of 346 electric stations, of which six belong to the national government or to the departments, 199 to the municipalities, and 141 to private operators. In 1942 they developed 293,782,493 kw-hrs. valued at 10,817,192 Colombian pesos. The country is considering the construction of a plant in the vicinity of Manizales, the cost to be about 2,000,000 pesos. A 12,000-kw. hydroelectric station is also planned for the Paez River, in the department of Huila, and another for Florencia in the Caqueta district. Other activities include the completion of a waterpower plant in the department of Boyaca and the beginning of operations on a station in that of Antioquia.

The government of Peru, with the aid of an Export-Import Bank loan, has a big hydroelectric development underway on the Santa River that flows into the Pacific just north of Chimbote Bay. Work on this project was initiated a year ago by Barton Jones, an electrical engineer previously associated with the Tennessee Valley Authority. It includes the installation of five generators of 25,000 kw. each. The first two units are expected to cost approximately $4,000,000 and to be ready for service by the end of 1945. To augment the electric-power supply of the city of Lima, a new dam is being constructed several miles east of the city. This will increase the power-generating capacity to 91,000 kw. At the end of 1942, Peru had an estimated output of 225,000 kw., or 13,000 more than at the close of 1940, production having increased 37 per cent since 1939 largely because of industrial growth.



LOADING FIREWOOD FOR THE IRON HORSE

This scene along the Sorocabana Railroad in Brazil will be a thing of the past when the electrification of the line now underway is completed. South America has limited commercial deposits of coal, and with importations curtailed by reason of the war, the railroads have to depend largely on wood to fire the locomotives.

Brazil has plans to harness the great Sao Francisco River with a series of dams and to exploit the agricultural and mineral resources—iron, gold, mica, bauxite, quartz, diamonds, and copper—of this 260,000-square-mile valley. The Sao Francisco is 1,800 miles long, and much of it is navigable. Just below the city of Itaparica is the great Paulo Affonso Cataract with a drop of 265 feet, and not far above is another falls which, combined, are capable of developing 800,000 hp. Still higher up are two more power sites.

Brazil also proposes to electrify more of her railroad mileage, and work has actually begun on the 90-mile section of the Sorocabana railway that connects Sao Paulo, the industrial metropolis of Brazil, with the important city of San Antonio. The line has a total length of 1316 miles and serves the Pocos de Caldes region of southern Brazil, an important center for bauxite and other minerals. One branch connects with the port of Santos. The road is double-tracked and of meter gauge; that is, its rails are about 39 inches apart. (Standard-gauge track measures 56½ inches from head to head.) The present rails are being replaced with heavier ones, and 180-ton electric locomotives, said to be the heaviest ever built for meter-gauge track, are to be substituted for the 80-ton locomotives now in use. Ten of the new locomotives have been ordered in the United States.

There is an abundance of waterpower accessible to the Sorocabana railroad, which now burns imported coal and firewood. All available wood within several miles of the line on either side has been cut, and the present supply must be hauled considerable distances. The entire electrification project will cost more than $10,000,000 and is expected to be completed in about three years. Brazil now has 1343 electric plants of various types, and these furnish light and power to 2179 communities. In 1940 her installed capacity totaled 993,742 kw. of which 732,000 kw. represented hydroelectric stations, 193,140 kw. steam plants, and the remainder diesel-engine plants. Most of the former are located in the industrial states of Sao Paulo and Rio de Janeiro.

Argentina finds herself in a relatively disadvantageous position so far as the development of hydroelectric power is concerned. Both the population and the industries of this republic are concentrated in the Atlantic seaboard area, in and around the Province of Buenos Aires, whereas the waterpower sites are several hundred miles away in the foothills of the Andes. At present Argentina has 700,000 kw. of installed electric energy of which 542,000 kw. is generated in the Province of Buenos Aires. There is available only 31,000 kw. of hydroelectric power, most of which is centered in the provinces of Mendoza, Cordoba, and Tucuman. The prospects are that this will be increased in the near future upon the completion of a number of irrigation projects that constitute a part of Argentina's public-works program. The plan is to impound the waters from a large area in the northern and western section of the country in a series of lakes, and thus make it available for purposes of irrigation and, wherever possible, for the generation of electric energy.

It is not hard to envision the benefits that will follow as a natural consequence of this large-scale program of hydroelectric development in Central and South America. It will lead first and foremost to great industrial expansion, make the nations less dependent than they now are on foreign sources of fuel, materials, and equipment of all kinds, and, equally important, help to solve a possible unemployment problem in the postwar era.

"Needled" Steel

IT IS well known that the war has placed increased emphasis upon alloy steels and that there is a scarcity of such alloying elements as nickel, chromium, and molybdenum. Fortunately, however, the discovery of a new alloying agent and of a new technique of producing steels that can be hardened sufficiently to withstand severe service promises to offset these shortages.

The magic element that is cast in this new role is boron, which occurs in one of its natural forms as borax, long useful in the household. It has been found that a group of ferroalloys containing boron have the property of markedly increasing the hardenability of many steels when added in relatively small amounts. These alloys are usually referred to as special addition agents, but also as needling agents and intensifiers.

German steel metallurgists seem to have done some experimenting with boron immediately following the previous war, and a United States patent pertaining to its use in steel was issued to Richard Walter of Duesseldorf in 1924. Nothing of commercial value was then developed, and there was no further activity until 1938. However, some American technologists had long suspected boron of having possibilities along these lines. Among them was R.B. Schenck, who, even before World War I, had devoted his college thesis to a description of a process for making ferroboron from calcium borate. Although nothing came of it at the time, Mr. Schenck retained his interest in boron, and as chief metallurgist of the Buick Motor Company has employed the new alloys in making motor-car parts.

According to Mr. Schenck, "The general effect of the special addition agents is to increase the hardenability and improve the mechanical properties of steel in the quenched and drawn state. In other than the quenched and drawn state, the additive seems to lower the mechanical properties. The improvement in mechanical properties is confined mostly to the plain carbon and low alloy steels and is most pronounced at low draw temperature in the range of 300° to 500°F." In sections capable of being hardened thoroughly, steels of the SAE 1000 and 1300 types will develop tensile values of the same order as high-alloy steels. With respect to hardenability and mechanical properties, it may be stated, in general, that a special-addition-agent treatment can produce a carbon steel that is the equivalent of a low-alloy steel and a low-alloy steel that is the equivalent of a high-alloy steel.

Besides boron, these additives may contain aluminum, calcium, manganese, silicon, titanium, and zirconium. In all cases, however, boron is present. They are generally added last to the steel in the ladle, but may be put in the ingot mold. It has been found that satisfactory results depend upon the use of an optimum amount of alloy, and that if this is exceeded, the hardenability of the steel will be below the maximum obtainable. The amount to be used depends upon the composition of the addition agent and upon the composition and degree of oxidation of the steel to which it is to be added. One mill may find that 2 pounds per ton of steel will produce optimum results; another may have to use 4 pounds. To obtain the same results with electric-furnace as with open-hearth steel, it is necessary to double the amount of additive.

Detecting Rock Bursts

IN SOME mines pressures build up until the rock bursts. This usually, but not always, occurs at deep levels, and as it presents a serious hazard, much study has been devoted to the phenomenon. The U.S. Bureau of Mines became interested in rock bursts some years ago, and Dr. L. A. Obert and his associates proceeded on the theory that, as pressure grows, there is probably some microscopic yielding of the rock, accompanied by subaudible snapping. To test this theory, they built a listening apparatus that could pick up faint noises, amplify them, and convert the energy into mechanical motion. Upon learning of this development, the Lake Shore Mines in Canada, which had begun investigations of its own, invited Doctor Obert to make tests on its property.

The pick-up equipment consists of a geophone that is housed in a steel tube 1¼ inches in diameter and 8 inches long. It is inserted in a diamond-drill hole and connected to an amplifier and recorder in an underground instrument room. Within the tube is mounted, in springboard fashion, a double, elongated crystal of Rochelle Salt closely wrapped in silver foil and connected to an electric terminal. A separate strip of silver foil is inserted between the layers of crystal and connected to a second electric terminal. When the tube is subjected to the impulse of subaudible snaps, the inertia of the crystal causes it to undergo a slight flexure, and this generates a momentary voltage difference at the two terminals. The weak currents are amplified about 500,000 times and are recorded on paper by a stylus that moves at the rate of 1½ feet per minute.

The tests have shown that small bursts or "salvos" precede actual bursts. The ground seems to be in a critical state of pressure when the number of snaps per minute approaches 100, although this has been exceeded without a burst occurring. Under these conditions, men and materials are removed from the zone affected. It has also been learned that pressures shift from one location to another within a few hours and that a burst in one section sometimes increases pressure in another sufficiently to cause a burst there. If none takes place, it is usually found that the number of snaps per minute soon begin to decrease and that mining can safely proceed in that area until further warnings are received.

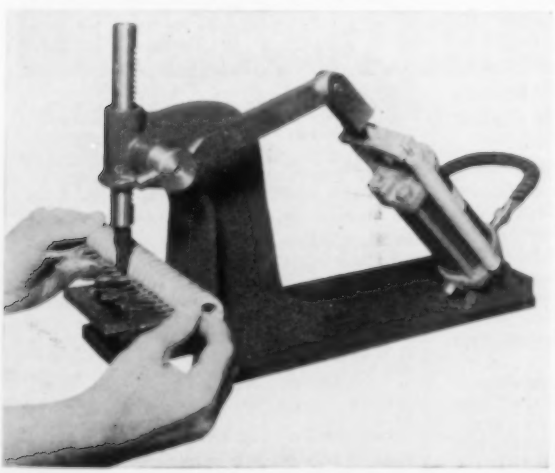
Industrial Notes

Steel-temp is the name of a new solution introduced by the Steeltem Chemical Company for hardening steel tools and parts. It is said to greatly simplify the work by eliminating the drawing of temper or color when quenching and to produce a tough, hard product that retains its cutting edge longer and is more resistant to breakage than steel treated in the usual way.

Texas may have to yield her claim to being the country's if not the world's foremost producer of helium. No less an authority than the U. S. Bureau of Mines has reported the finding near Gallup, N. Mex., of deposits of this non-explosive gas that may prove equal to if not larger than those in Texas. Test wells, according to government officials, have shown a high helium content.

Kover-Oil, made by Rock-Tred Corporation, is a protective covering for machinery, motors, floors, walls, or other surfaces that are exposed to excessive oil or grease. It is applied by brush or air spray and is said to set in about twenty minutes, forming a hard surface that can be kept clean easily. Wood, concrete, and other porous materials require two coats to make them impervious. The liquid is available in four standard colors—buff, gray, red, and green.

The accompanying picture shows an arbor press that has been converted from hand to foot control by a pneumatic cylinder supplied with air at 90 pounds line pressure. Through the medium of a lever arrangement, a pressure up to 1500 pounds is exerted at the work point. The ram has a maximum vertical travel of ½ inch and remains down until the pedal is released, when springs alongside the cylinder return it to the "up" position. As a result of this modification the operator can do consistently better work with less fatigue. The press is shown assembling eyelets on resistor units. The improvement was suggested by a methods man at the General Electric Schenectady Works.

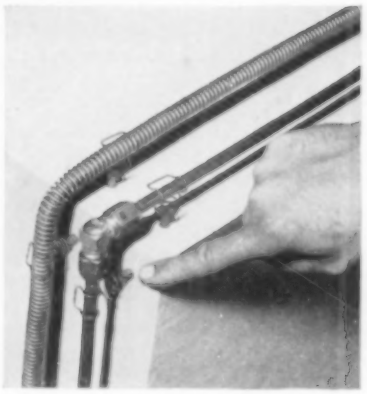


With winter upon us, and greater need than ever of keeping heat within doors, Mortite Tape may prove to be an item of interest. It's a new weatherstripping that is simply pushed into place and can be removed at the end of the season for reuse, it is reported. The material comes in convenient coil form and is also suitable for calking, glazing, packing, etc. It is made by J. W. Mortell Company.

Infrared lamps have been introduced into the foundry where they are facilitating skin-drying of green sand molds. The equipment is portable and can be used singly or in pairs to handle molds measuring up to 46x36x36 inches and 70x46x36 inches, respectively. Each drier has a heater assembly made up of twenty-four 250-watt lamps arranged in six sections. It can be lowered and raised and plugged into any standard 110-volt power circuit.

Salvage Manual for Industry, a 245-page book announced by the War Production Board, is said to be the most comprehensive and practical handbook on salvage that has yet been published. Edited by a board of engineers and business-paper editors, the book contains 26 chapters devoted to the following topics: organizing and planning the salvage department; administrative factors; methods of handling metal scrap; non-metallic waste; case histories, etc. Assisting the editors with advice and contributions was a staff of some 40 engineering and salvage experts. The price of the book is 50 cents per copy. It is procurable through the Superintendent of Documents, Government Printing Office, Washington, D. C.

Aircraft builders desiring a simple means of eliminating the whip of hose in airplane engines are responsible for the appearance of an ingenious vibration absorber for both flexible and rigid tubing. It was developed by the Packless Metal Products Corporation and consists of a combination cone-spiraled spring and clip that snaps onto the piping. Flexing in all directions, the absorber can be secured to the supporting surface in either a lateral or a vertical position. Any impact results in compression of the cone,



thus cushioning the tubing, and abrading contacts at bends are prevented by placing a fastener on each side, as shown.

As a substitute for copper tubing required for many industrial and domestic purposes, Everhot Products Company is offering a steel tube that is copper-coated both inside and outside. The claims made for it are that it can be bent to virtually any shape and can be hard or soft soldered, brazed or welded. It is distributed under the name of Bundyflex and comes in sizes ranging from ⅛ to ⅝ inch outside diameter.

Use of a pine-wood chemical in the making of armor-steel castings for combat vehicles has broken a foundry bottleneck, according to the Hercules Powder Company. Before the war, each ton of cast steel usually required half a ton of new, specially graded silica sand. With production stepped up to unprecedented heights after the outbreak of hostilities, foundries experienced difficulty in obtaining the core material, and it was then that they learned to mix pulverized resin extracted from southern pine wood with new or mechanically reclaimed old sand. Truline Binder, as the resin is called, is said to be especially effective with clay-bearing sands and is destroyed by heat after casting, thus permitting easy removal of the sand from the core cavity. In the case of one foundry making 5000 tons of armor-steel castings each month, the resin cut the monthly new-sand requirement from 2500 to 600 tons.

Extra fuel carried by airplanes for long-range flights is stored in tanks suspended from beneath the fuselage so they can be dropped when necessary. The newest of these so-called "jettison tanks" are made of specially processed paper. The containers are cigar-shaped to lessen wind resistance, and each is made up of three sections consisting of layers of paper glued together and shaped by molding. After the parts have

been dried and sandpapered, bands of wood are inserted between them and they are joined by metal fittings. Before the tanks are ready to leave the factory they are given an outer coat of dope and a final finish of silver cellulose paint applied by air spray.

To the present five commercial types of synthetic rubber available in the United States has been added a new one —Uskol, which has been developed by the United States Rubber Company. It is said to offer high resistance to solvents, and will be used in the manufacture of commodities that come in contact with fuels, oils, gasoline, dry-cleaning fluids, etc. This is interesting, because there is a possibility that we may, for the first time, get raincoats that can go to the cleaners. The material can be molded, but is not suitable for tires.

The practice of spraying rock dust in bituminous-coal mines to prevent explosions is becoming more widespread in the United States, according to a report made by the U. S. Bureau of Mines. The amount used has increased from 137,000,000 pounds in 1930 to 344,000,000 pounds in 1941, the last year for which complete figures are available. The quantity applied per ton of coal produced has also grown from 0.93 pound to 1.31 pounds within that period. Rock-dusting is one of the most promising means of reducing the death rate from accidents in collieries. However, to be effective, it is necessary that it be scattered throughout all the workings and in such amounts that the proportion of rock dust to coal dust in the mine is sufficient to constitute a nonexplosive mixture.

Model 75-AC coolant cooler recently put on the market by Frostrode Products is a self-contained portable unit that is said to control automatically and accurately the temperature of coolants and lubricants in machine processing. It is equipped with a motor-driven, air-cooled compressor and effects maximum heat transfer through the use of a single, steel-tube evaporator coil based on the counter-flow principle. The cooler is simply rolled up to a machine, and once the coolant and electric connections have been made and the operator has set a dial at the coolant temperature desired, it works without attention, even variations in room temperature being compensated for by a differential thermostat. The rated capacity is 18 gpm. when the coolant temperature is down to a point where it is 20°F. below room temperature. The unit is adaptable, it is claimed, to well-nigh any machine involving the use of coolants, and is especially suitable for heavy cutting and high-pressure grinding operations.

Thousands of vital man-hours are being saved and accidents prevented in the plant of Willys-Overland Motors, Inc., by the use of a "safety schooner" that was designed by the company's own engineers. The mobile unit is equipped to service and repair goggles, aprons, safety shoes, helmets, face shields, and any other protective devices worn by the more than 14,000 workers employed there. It also carries spare parts and complete replacements and is provided with a special antiseptic tank for sterilizing the equipment that comes in contact with the face so as to check the spread of colds and other diseases. Every department in the plant is visited by the schooner once every two weeks, thus making it possible for the men to remain at their benches and to keep up production while their safety equipment is inspected, cleaned, repaired, or renewed.

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A CONVENIENT CONDENSED GUIDE TO THE LATEST IN

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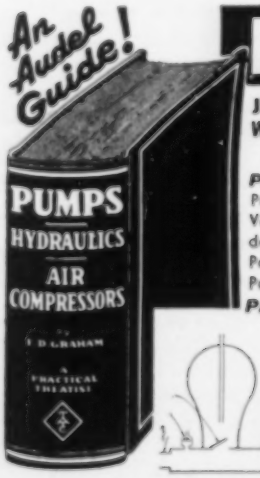

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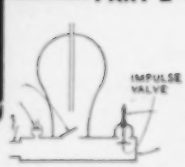

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Ordinary wire V belts are made by winding a continuous wire around a drum, then cutting into narrow sections to form the individual belts. Thus in ordinary belts there is a point on each side where the wire is close to the edge. The B. F. Goodrich grommet is made by forming wire cable into a loop, then winding it spirally on itself up to the needed size. It's endless; in the belt it is always the same distance from the edge (wires will never be exposed by slight wear); it has less stretch than small individual cables, more strength for a given amount of wire. Thus it transmits more horsepower for a belt of given size.

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This new principle makes the strongest V belt ever produced in proportion to size and weight. The well-known V belt advantages of efficient power transmission, low maintenance, long trouble-free life, quiet and clean drives, less weight are now available for many drives which have always had to put up with heavier, costlier methods.

If you have drives on which other belts have failed — or drives on which lack of strength has made former V belts impractical — write B. F. Goodrich. Our belt specialists will help you engineer this revolutionary new belt to your drives to give you greater power efficiency, and save you money, trouble and production time. *The B. F. Goodrich Co., Industrial Products Division, Akron, Ohio.*

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FOR THE HOUDRY PROCESS

The Houdry catalytic process is an important factor in the production of the tremendous quantities of 100-octane aviation gasoline used in our war effort.

It was found that an entirely new type of pump was required for the process. Ingersoll-Rand was requested to develop a suitable pump by the engineers of the Houdry Process Corporation, Socony-Vacuum Oil Company, and E. B. Badger & Sons Company, who were collaborating in the design and construction of these plants.

The pumps were to handle a molten mixture of sodium and potassium nitrates and nitrites. The molten salt is used to control the catalytic reactions employed in the process. This salt mixture, which possesses no lubricating qualities, is used at a temperature of 800-850°F.

Ingersoll-Rand, whose engineers have had years of experience with pumps for the refinery field and for high temperature service, developed a vertical pump with axial and centrifugal flow characteristics. Today practically all Houdry plants are equipped with Ingersoll-Rand hot salt pumps. They have been developed in sizes from 10 to 600 hp. to meet the demands of different installations. The first of these pumps went into service more than four years ago. Their exceptional performance has resulted in many repeat orders. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N. Y.

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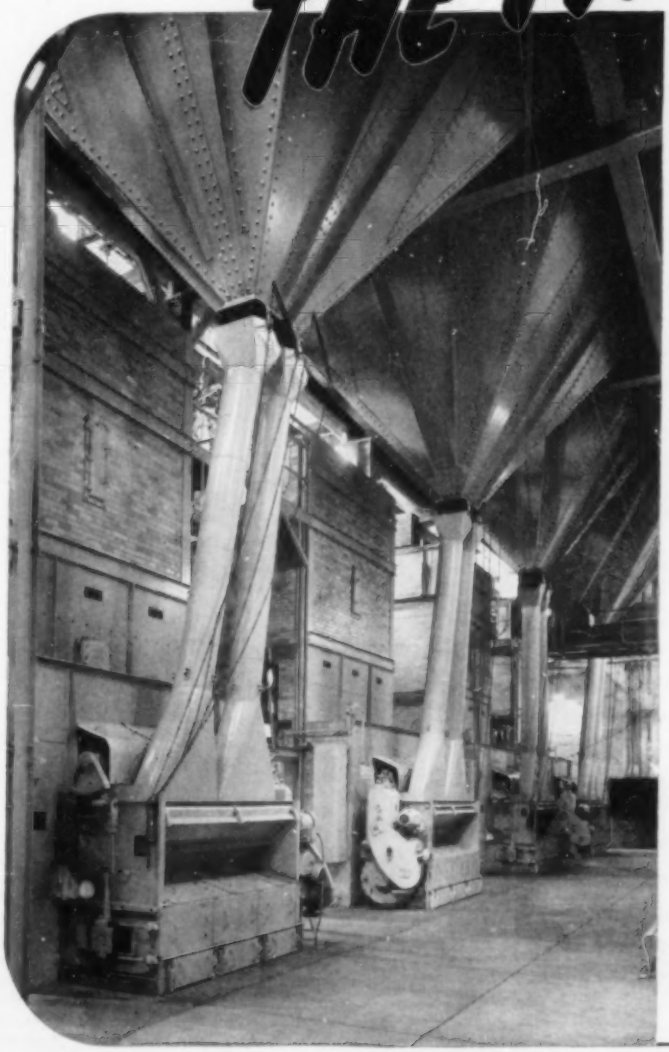

Spearheading the tremendous production of guns, planes, tanks, and ships for our fighting forces, are the boiler room firing aisles of industry! Here, steam generating units are called on to meet extraordinary operating requirements day after day with minimum maintenance.

Vogt steam boilers are making outstanding records for efficient steam generation in tough war plant service throughout the Nation.

Vogt WATER TUBE BOILERS

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Walworth No. 709—screwed end
Service Pressure Steam
¼" to 2" . . . 150 pounds
2½" to 3" . . . 125 pounds
Non Shock Service Pressure—
Cold oil, water or gas
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1" to 3" . . . . 125 pounds
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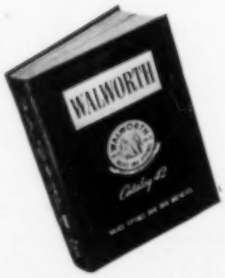
Walworth
Iron Body Bronze Mounted Wedge Gate Valves
with Screwed ends or Flanged ends

Where ease of inspection or cleaning is essential, this saddle gate valve with its U-bolt body-to-bonnet connection fits the service. It is an ideal valve for lines carrying sludge, fluids of high viscosity, or mixtures which might have a tendency to clog under the disc or between the valve seats.

Walworth No. 709 Bronze Mounted Screw End Valve has wedge, seat rings, stuffing nut, gland bonnet bushing, and stem of bronze, but the rest of the valve is made of iron. Two drain holes inside the bonnet eliminates the danger of damage due to fluid freezing in the bonnet. The sturdy construction common to both screwed and flanged end types is clearly shown.

By using Walworth Iron Body Bronze Mounted Wedge Gate Valves at this time you will help to conserve copper – a critical war metal.



To help you "fit the valve to the service," you'll find pertinent information on Walworth's complete line of valves, fittings, pipe, and pipe wrenches in the New Walworth Catalog 42. Included are 78 pages of practical engineering data that simplify valve selection and make piping layouts easier. Write, on business stationery, for your free copy. Address: Walworth Company, 60 E. 42nd St., New York 17, N. Y., Department D17.

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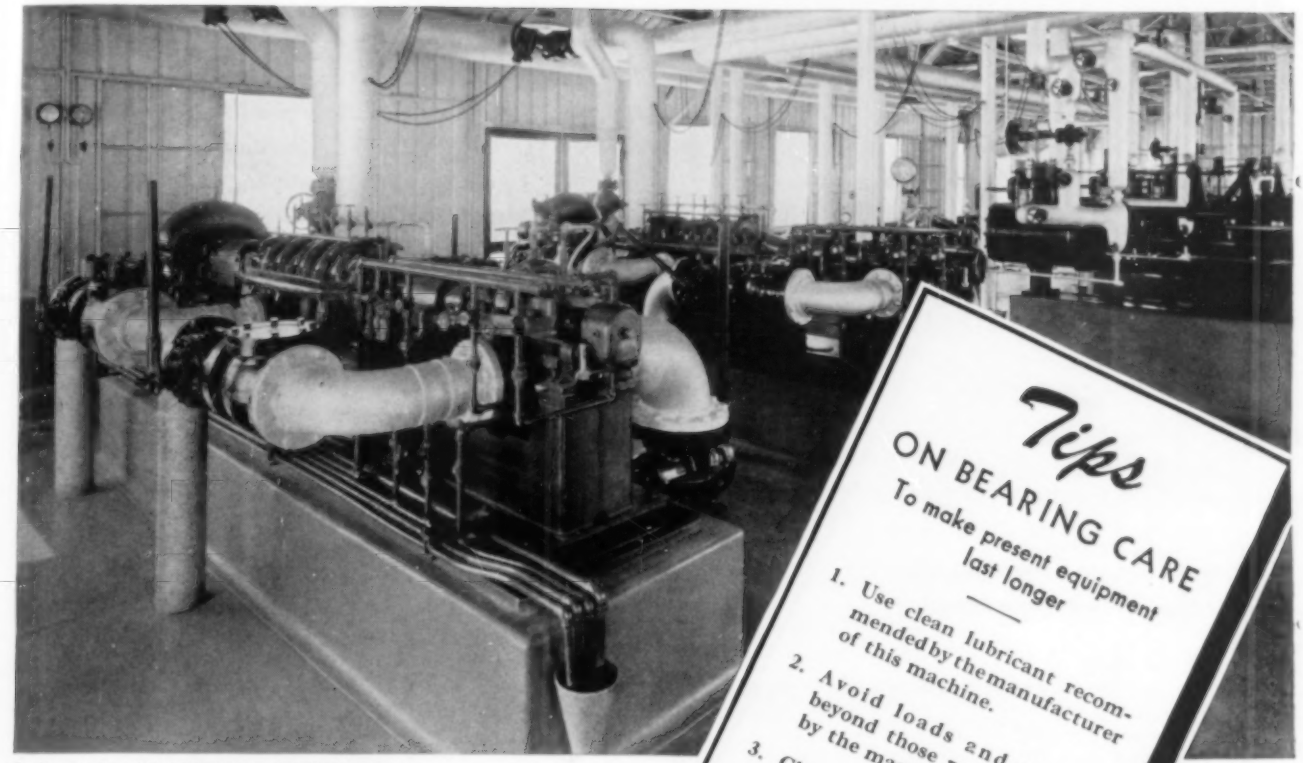
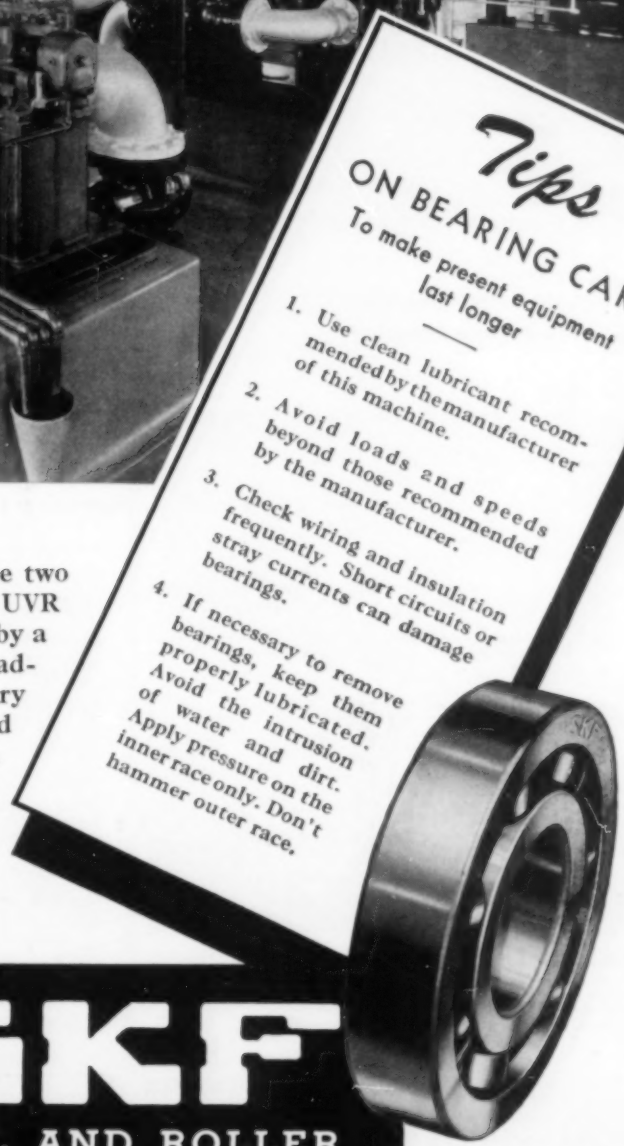


● *Built by* INGERSOLL-RAND CO.

The work of SKF Ball Bearings on these two pumps is never done. On these NT-6 and UVR pumps connected in tandem and driven by a steam turbine, they roll smoothly and steadily. Their work day is 24 hours long . . . every *day* . . . every *year*. And each day is filled with SKF's keeping close tolerances *close*, absorbing radial and thrust loads, never needing attention. They—like other SKF's on planes, guns, ships, etc.—are adding an outstanding contribution to the war effort. 5425


Tips
ON BEARING CARE
To make present equipment last longer
1. Use clean lubricant recommended by the manufacturer of this machine.
2. Avoid loads and speeds beyond those recommended by the manufacturer.
3. Check wiring and insulation frequently. Short circuits or stray currents can damage bearings.
4. If necessary to remove bearings, keep them properly lubricated. Avoid the intrusion of water and dirt. Apply pressure on the inner race only. Don't hammer outer race.

ARMY E NAVY

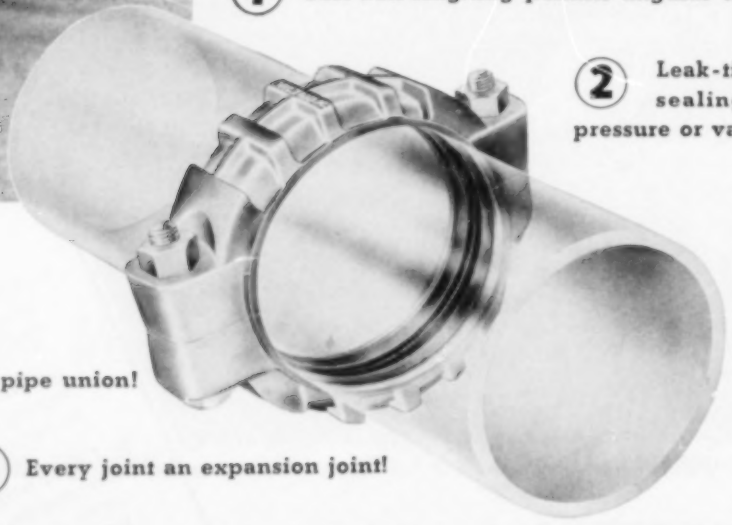
SKF
BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILA., PA.

A PIPELINE THAT WON'T STAY BOMBED OUT!

It bends with the blast of near misses as illustrated in the training picture you see here. At the battle front when sections are destroyed by direct hits or by big bombs hitting nearby, new pipe can be laid and coupled in a matter of minutes. The reason? The couplings of thousands of miles of the Blitz pipelines, that are helping make rapid troop advances possible, *are Victaulic.* Add up the 5 basic Victaulic advantages and you'll see why the Victaulic method of coupling pipe is not only faster but better at home, too.

1 **Fast Self-Aligning permits angular deflection!**

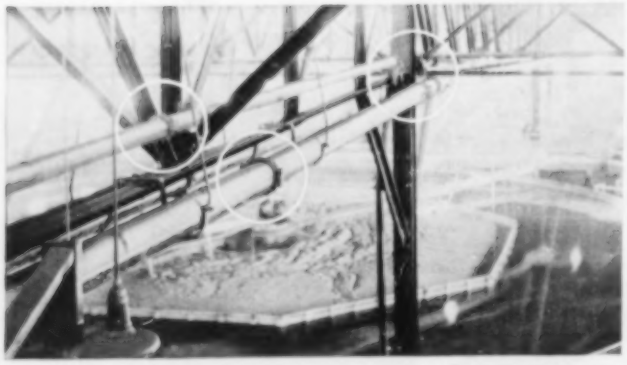


2 **Leak-tight, self-sealing under pressure or vacuum!**

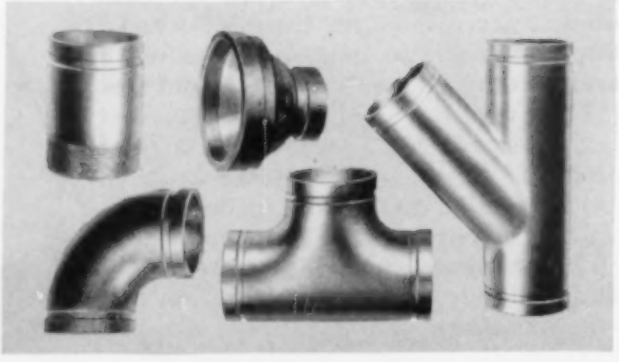
3 **Positive mechanical lock of pipe lengths!**

4 **Every joint is a pipe union!**

5 **Every joint an expansion joint!**



DOLLAR SAVING FEATURES FOR INDUSTRIAL CONSTRUCTION! Installed faster and with less labor than any other method. A small socket wrench is the only tool needed. Victaulic joints are compact, flexible. Provide substantial savings in space and weight. Temporary lines can be salvaged 100 per cent. Maintenance is nil on permanent jobs.



VICTAULIC FULL-FLOW FITTINGS eliminate the tedious work of ordinary pipe fitting. Long easy sweeps and smooth true-circular walls reduce friction losses. A real contribution to speed and ease of installation and greater efficiency in conducting fluids and gases in pipe systems!

BUY MORE WAR BONDS!

INDUSTRIAL

VICTAULIC

SELF-ALIGNING PIPE COUPLINGS

AND FULL-FLOW FITTINGS

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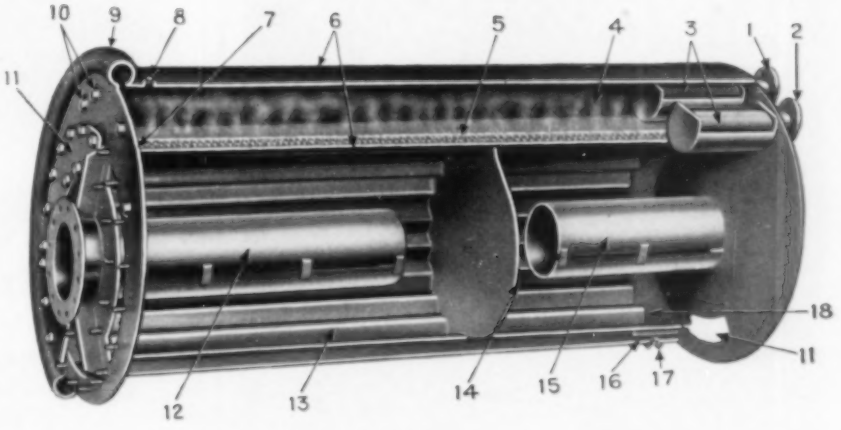
MAXIM HEAT RECOVERY SILENCERS *save fuel!*

Extra steam or hot water for industrial processing operations or for heating purposes can be readily obtained by utilizing waste exhaust heat with Maxim Heat Recovery Silencers. The fuel saving is obvious, as the heat source is simply the engine exhaust gases which normally are wasted.



1—Steam Outlet
2—Safety Valve Connection
3—Dry Pipes
4—Steam Space
5—Water Line
6—Shells—Cylindrical to withstand steam pressure and pulsating gas flow
7—Inlet Head
8—Pressure Gauge Connection
9—Expansion Joint—permits dry operation
10—Water Gauge Connections
11—Cleanouts—provide easy access for cleaning heating surface
12—Inlet Bleeder Tube
13—Extended Heating Surface—forming conduits for leading exhaust gases from one attenuating chamber to the other
14—Insulated Intermediate Head
15—Outlet Bleeder Tube
16—Feed Water Deflector Plate
17—Feed Water Connection
18—Exhaust Gas Outlet from side conduits formed by extended heating surfaces

HIGH HEAT RECOVERY . . . Maxim Heat Recovery Silencers achieve highly efficient heat transfer through high mass gas velocities and the use of extended heating surfaces, a type of construction that is extremely dependable and requires minimum attention.

HIGH DEGREE OF SILENCING . . . These units embody the Maxim principle of silencing and can be had with or without the spark arresting feature. Based on silencing principles pioneered by Maxim and developed through years of practical field experience, they afford highly effective silencing of exhaust with minimum of back pressure.

COMPACTNESS AND LIGHT WEIGHT . . . Maxim Heat Recovery Silencers are extremely compact and can in most cases be installed in the space normally used for a regular silencer unit.

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ABILITY TO RUN DRY . . . Because of the type of construction, with extended heating surfaces, not tubes, it is possible to run these units dry without any danger of damage.

QUICK RETURN ON INVESTMENT . . . Maxim Heat Recovery Silencers produce usable steam or hot water from a present source of heat. Hence steam or hot water for processing operations or for heating the plant is available with no extra fuel cost. This obvious saving represents a quick and often substantial return on your investment.

AVAILABILITY . . . At this time the Maxim Silencer Company's production is devoted to war needs. It is our feeling, however, that this Waste Heat story has sufficient post-war importance to make your investigation worthwhile now, whether or not your present priority status allows immediate purchase of the equipment.

This northern Minnesota power plant is heated entirely through use of Maxim Heat Recovery Silencers.

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Maxim Waste Heat Bulletins WH-100, WH-102 and WH-103 will be sent to you on request. Simply send your request to The Maxim Silencer Company at the address below.

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National Forge machine shops are equipped with an impressive number and variety of modern machine tools designed for the finishing of heavy duty steel forgings. And every machine is manned by one or more master machinists intent on maintaining National Forge precision standards. Checked and re-checked by rigorous inspection throughout the machining process, National Forgings have the same high standing for quality machining that they have long held for the cleanliness of their steel and the skill of their forging. When you need that kind of forgings be sure they are National Forged.

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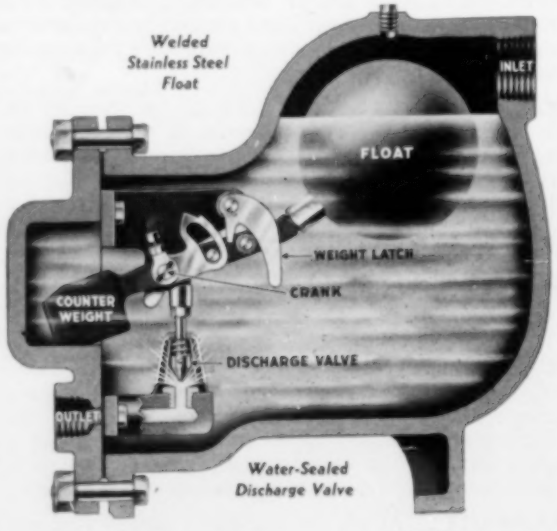

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FOR AUTOMATICALLY DRAINING AIR TANKS SEPARATORS, RECEIVERS, AFTER-COOLERS, ETC.

Specially designed and constructed to provide long, trouble-free service. Large capacity. Pressures to 200 lbs. Intermittent discharge. Bulletin No. 341.

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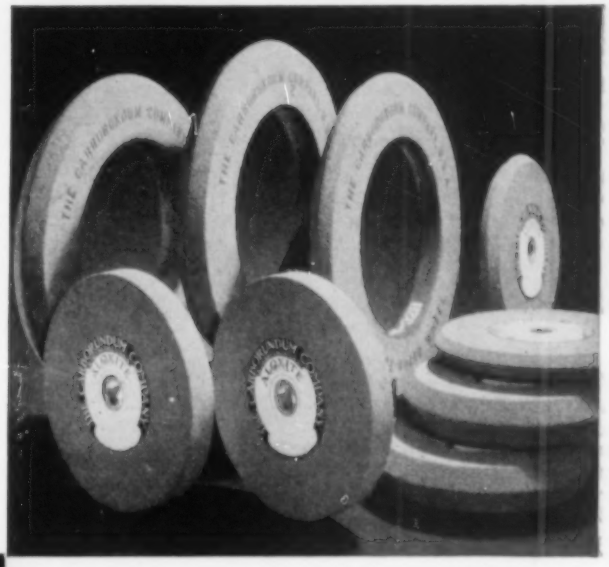

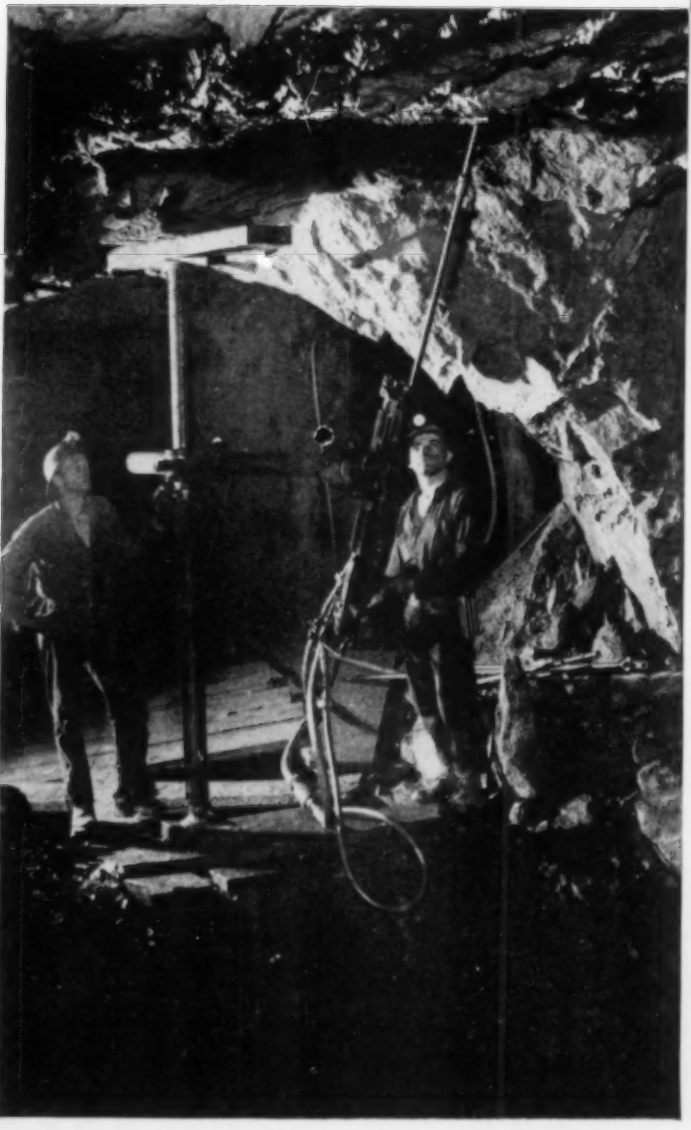

TO get the most out of your detachable bits, you've got to use the *right* grinding wheels for your forming and gauging operations . . . wheels that hold their shape and cut free, fast and cool. You get accurate gauge and form, longer tool life between grinds, reduced grinding time and a lower cost per grind.

And if you don't know the advantages of detachable bits, here they are. They reduce steel shop costs and nipping charges. They permit more time for drilling because you don't have to carry steel in and out of working spaces. They drill faster than ordinary steel drills—even in soft or muddy ground.

All that's needed to keep them in condition is a simple forming and gauging operation with the right grinding wheel. No forging or retempering is needed.

May we remind you that every grinding wheel is a "Weapon for Production" and to use it wisely?

Every hour this war is shortened will save $12,000,000. The lives it will save are priceless. Let's get it over with—quickly!

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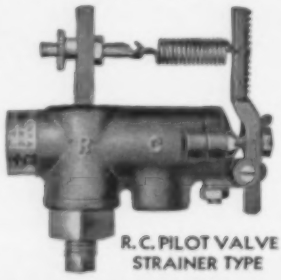
R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R. C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

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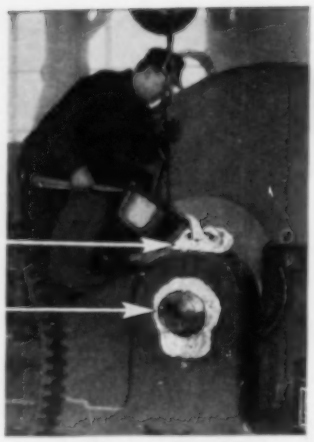

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Here is a babbitt retainer which has a 20-year record of *sticking to the job* under all working conditions. It is not affected by heat, is moisture-proof, will not melt, harden or dry out and speeds up babbitting operations. It provides absolute protection to workmen because it does not "blow out". Comes ready for use. May be re-used 100 times or more.

Write for a liberal sample.

Babbitrite
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PRODUCTS MFG. CO.
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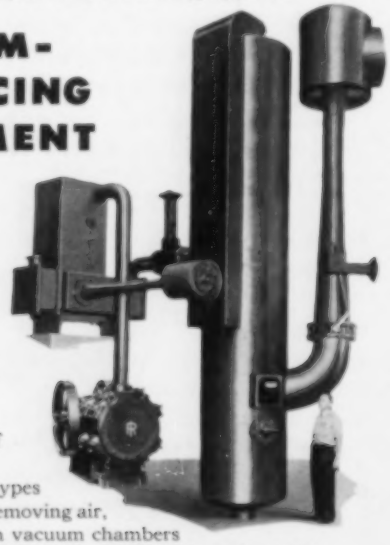
Combination steam-jet and reciprocating vacuum pump equipment used in a humidifying process.

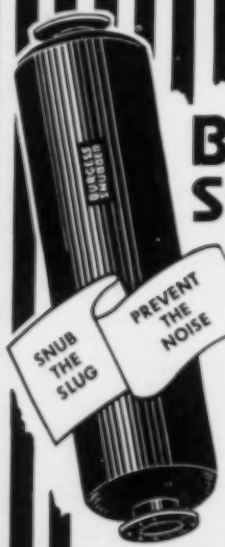
VACUUM-PRODUCING EQUIPMENT



★ Steam-jet ejectors are one of the simplest and most economical types of equipment for removing air, gas or vapors from vacuum chambers in industrial processes. Ingersoll-Rand has a complete range of sizes for all capacities, and absolute pressures as low as 50 microns Hg. Ejectors will handle wet or dry mixtures, and can be designed to operate with practically any available steam pressure. Ingersoll-Rand also builds a complete line of other vacuum equipment including surface and barometric condensers, reciprocating dry vacuum pumps and steam-jet refrigeration units.

4-289

Ingersoll-Rand
11 BROADWAY, NEW YORK CITY



BURGESS SNUBBERS for Quiet Compressor Intakes

Acoustic Division
Burgess Battery Company
2823-I West Roscoe Street
Chicago 18, Illinois

The things

Burgess-Norton are doing today will Someday soon be Available to all Manufacturers...

- In PISTON PINS including aircraft
- In Hydrogen Copper Brazing
- In Precision—Screw Machine—Heat Treated and Ground Products
- In Ball Bearings—Non-Precision Types

A Part is never made right unless it is satisfactory to our customers.

Burgess Norton
MANUFACTURING COMPANY
40 years in GENEVA, ILLINOIS

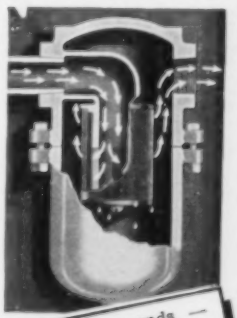
For dry, clean, oil free COMPRESSED AIR

USE THIS 2-WAY SEPARATOR

WATER, dirt and oil have no place in compressed air. They deteriorate air hoses and equipment rapidly, besides causing imperfect results in many services.

The Johnson Gast Separator combines the two most effective methods of removing these objectionable substances. First the air is allowed to expand, precipitating most of the moisture. Then it passes through the "thousand baffles", changing direction of flow many times and surrendering particles of water and dirt at every turn.

When water has been vaporized by the heat generated in compressing air, the Johnson Gast Aftercooler is installed ahead of the separator to condense the vapor. For services where every trace of oil must be removed—as in paint spraying—the Johnson Gast Oil Absorber is used.



1. Air expands — precipitates moisture.
2. "Thousand Baffles" change flow direction—capture remaining water and dirt.

Johnson Gast Separators also available for use on steam lines.

Write for Bulletin

THE JOHNSON CORPORATION
830 Wood St., Three Rivers, Mich.

JOHNSON-GAST
SEPARATORS • AFTERCOOLERS • OIL ABSORBERS

U. S. Army Air Corps

TODAY

Garlock is helping America's war industries and essential civilian industries maintain top-speed production by supplying them with Garlock products that give long, dependable service.

AFTER THE WAR

Garlock will continue to manufacture quality packings, gaskets and oil seals—for America's peace-time industries. The Garlock Packing Company, Palmyra, New York.

Garlock

WAGNER
COMPRESSOR MOTORS

★ ★ ★ ★ ★

When you need compressor motors to help you carry on essential production, specify WAGNER. 29 sales and service branches, located in principal cities, are ready to help you in selecting the RIGHT Wagner Motor.

WRITE FOR BULLETINS MU-182 — MU-183

M43-19

Wagner Electric Corporation
ESTABLISHED 1891
6418 Plymouth Avenue, St. Louis, Mo., U. S. A.
ELECTRICAL AND AUTOMOTIVE PRODUCTS

You can't laugh off a Sixty Year Safety Record

The Genuine **CROSBY CLIP**

For sixty years — since 1883 — the Genuine CROSBY CLIP has proved its dependability on every kind of wire rope installation. Why take a chance when you have this proof of CROSBY SAFETY? You get all of these safety features when you standardize on the Genuine CROSBY CLIP:

1—Correct Gripping Design.
2—Drop forged steel base.
3—Oversize U-bolt and nuts.
4—Ease of application.
5—Hot dip galvanizing — sure preventive of rust and corrosion.

Write for our interesting illustrated book, "With An Eye To Safety".

AMERICAN HOIST AND DERRICK CO.
Chicago San Francisco New York
SAINT PAUL, MINNESOTA
1883 - 1943
AMERICAN TERRY DERRICK CO. SOUTH KEARNY, N. J.
FOR SAFETY

GREATER PNEUMATIC EFFICIENCY

DriAir may be suspended from overhead piping without any other support.

A typical installation showing DriAir standing on the floor next to the wall.

SEPARATES • COLLECTS • DELIVERS

WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTA NED UNIT

DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

Write for Bulletin DA which fully describes the construction and operation of the DriAir.

NEW JERSEY METER COMPANY
PLAINFIELD, NEW JERSEY

NO OTHER COUPLING
gives all its operating advantages

WALDRON GEAR TYPE COUPLING

1. Positive seal protects against dust and oil leakage.
2. Hubs and Cover Sleeves are Heat Treated Forgings.
3. All metal contact parts constantly lubricated.
4. Longer lining up surface of hubs.
5. Cover sleeves function as single rigid unit.

Our Catalog 56 gives tables of Service Factors, Sizes and Ratings. Write for copy.

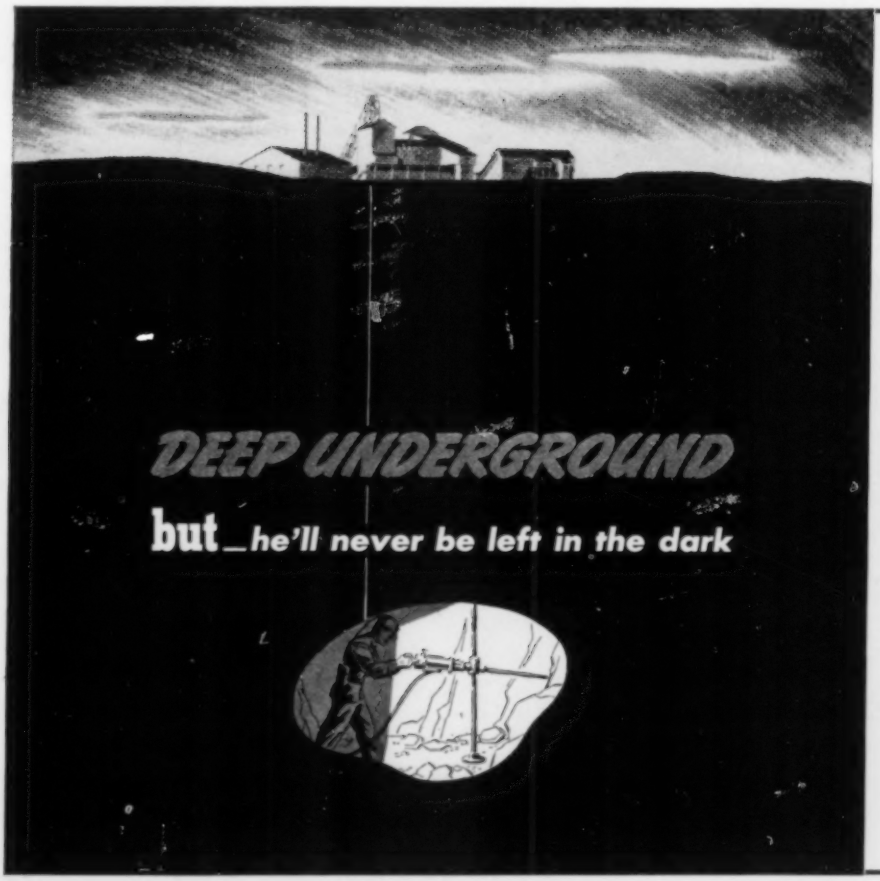
Although war work needs receive our first attention, we invite your inquiry.

JOHN WALDRON CORP.
NEW BRUNSWICK, N. J.

NO GREASE OR OIL FITTINGS
on
WISCONSIN
HEAVY-DUTY AIR-COOLED
ENGINES

In today's war production set-up, even the saving of fractional manpower for servicing grease cups and oil fittings is important. And neglect of this attention can mean serious damage to irreplaceable production equipment. This can't happen with Wisconsin Engines because there are no grease cups or oil fittings; no lost manpower; no chance for human error or carelessness. Wisconsin Engines are protected by positive force-feed and splash lubrication.

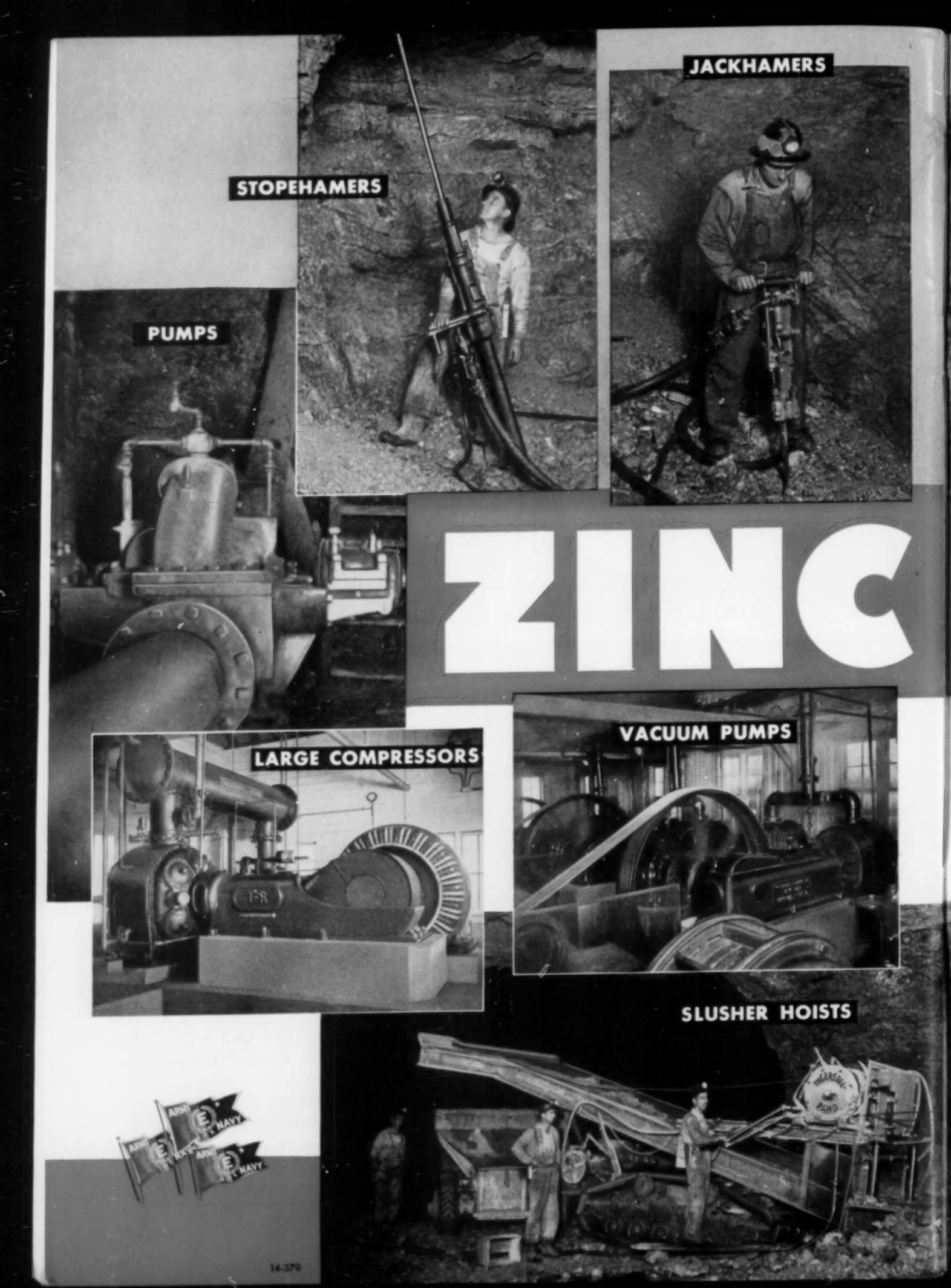
MOST POWER Per POUND
WISCONSIN MOTOR Corporation
MILWAUKEE, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

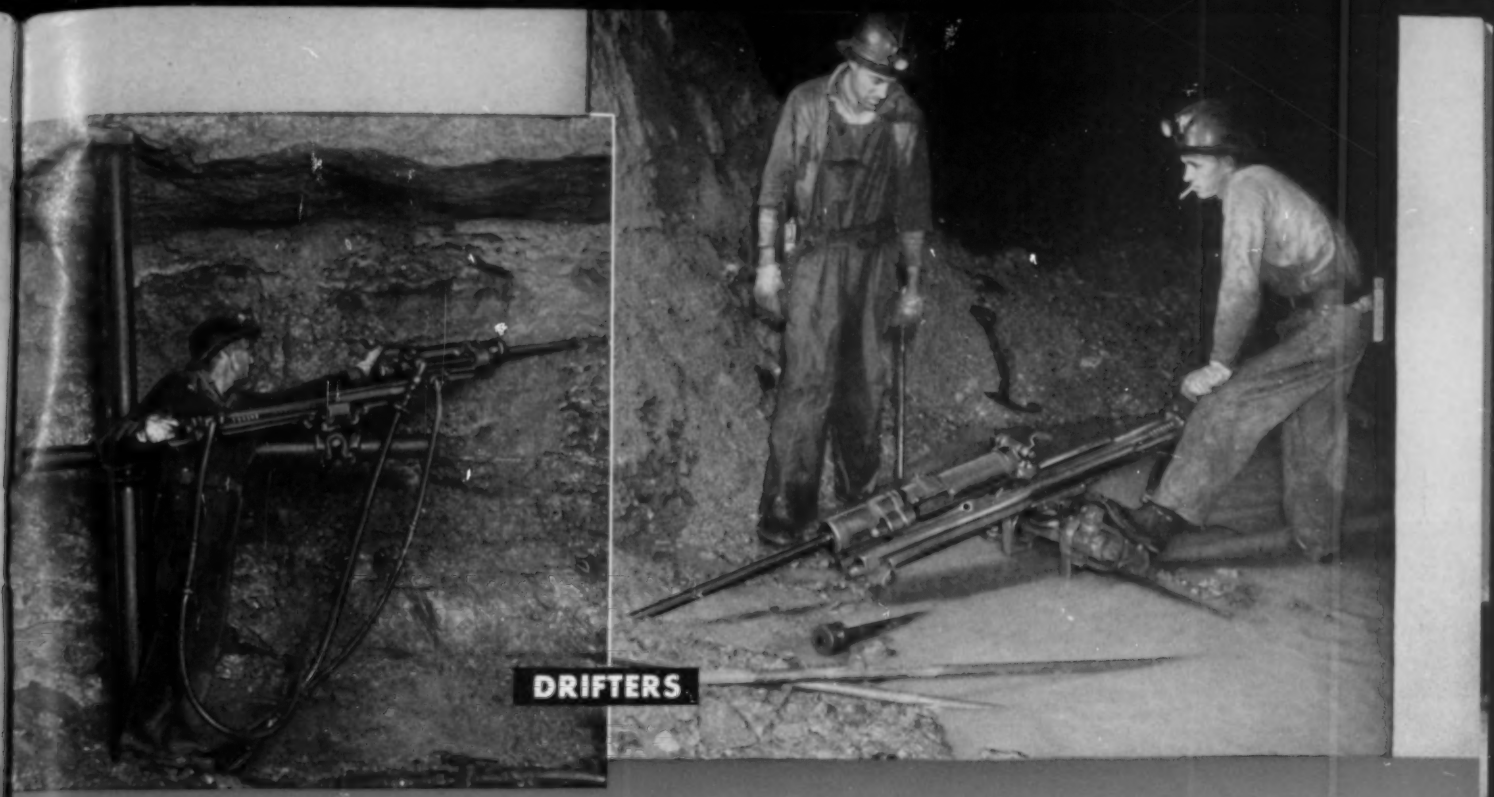


KEEPING faith with the miner in his fight for production victory is the steadfast dependability of the Edison Electric Cap Lamp. Furnishing more effective light, in greater volume, for greater daily tonnage, the Edison Lamp is engineered and built for continuous trouble-free service—to the last specification and the last ounce of material.

Better light makes better miners—and the Edison Lamp lives up to its responsibility of providing better light throughout every shift. Armed with the Edison Lamp and its sturdy companion, M.S.A. Skullgard, today's miner is well-protected against underground hazards—while doing an essential job for America.

MINE SAFETY APPLIANCES CO.
Braddock, Thomas and Meade Streets
PITTSBURGH, PENNA.
District Representatives in Principal Cities


STOPEHAMERS
JACKHAMERS
PUMPS
ZINC
LARGE COMPRESSORS
VACUUM PUMPS
SLUSHER HOISTS
INGERSOLL-RAND
ARMY-NAVY
14-370



DRIFTERS

and LEAD

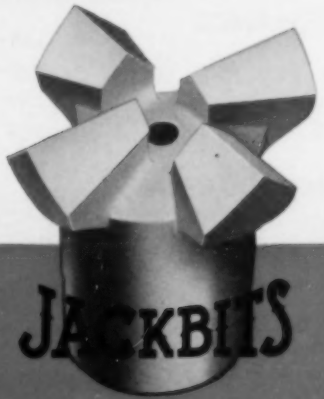
SMALL COMPRESSORS

EAGLE-PICHER PRODUCES FOR VICTORY ★ ★ ★ ★

Out of the many Eagle-Picher mines and mills, comes a large percentage of the zinc produced in the United States. Such output is amazing since it comes from some of the lowest grade lead and zinc ores mined in the world.

Eagle-Picher's progressiveness has made this production possible. This company is constantly devising new mining methods and putting to work the latest and most efficient mining equipment.

Ingersoll-Rand is proud and appreciative of the fact that Eagle-Picher Mining & Smelting Co. uses I-R Rock Drills, Compressors, Hoists, Pumps, Jackbits and accessory equipment in getting out its huge tonnages for victory.

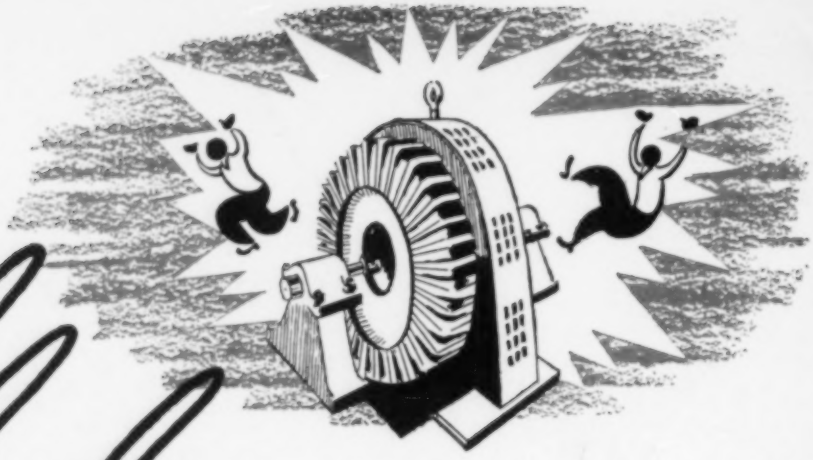


JACKBITS

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS



Flashover AT 10 PM

back on the line next afternoon at 3

200 KW GENERATOR FLASHED OVER AND GROUNDED—WAR PRODUCTION HALTED AT 10 PM. UNIT DISMANTLED, NEW BRUSHHOLDER INSULATION TUBES MADE UP (BY NEAREST WESTINGHOUSE MANUFACTURING & REPAIR PLANT), RUSHED BACK TO THE PLANT AND INSTALLED. GENERATOR BACK ON THE LINE AT 3 PM. SEVENTEEN HOURS FROM PRODUCTION STOPPAGE TO PRODUCTION AS USUAL.

Westinghouse
MANUFACTURING AND REPAIR

J-90454

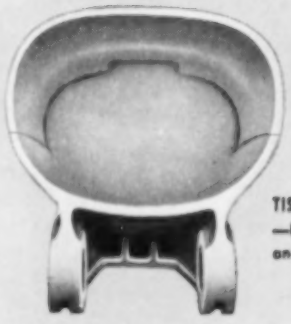
IF **THE EQUIPMENT NEEDING MAINTENANCE OR REPAIR IS VITAL TO THE WAR EFFORT . . . PHONE OR WIRE THE NEAREST WESTINGHOUSE "M & R" PLANT FOR**

EMERGENCY SERVICE

33 PLANTS . . . ONE NEAR YOU!

Lost in Action!

TISCO
MANGANESE STEEL
DREDGE BUCKETS



TISCO Rivetless Buckets —Patented in the U.S.A. and other countries.

TISCO Flexible Tongue Pin Lock— Patented in U.S.A. and other countries.

TISCO Riveted Bucket.

WHEN the Jap hordes swept South, through Thailand, Burma, Malaya and the Netherlands East Indies, two-thirds of the world's tin supply was lost and some of the world's finest tin dredging equipment was destroyed or captured. Many of these giant dredges were equipped with TISCO Manganese Steel Dredge Buckets—chosen for their outstanding ability and efficiency.

The manufacture of dredge buckets must wait for our present job of supplying ordnance for victory, repeating a task we have undertaken in every war since the Revolution.

When the Japanese scourge has been forever wiped out, tin dredging in the Far East will start again with newer and better equipment, and TISCO Manganese Steel Dredge Buckets will be better made and do a better job than those "LOST IN ACTION".

Est. TW 1742

Taylor-Wharton Iron and Steel Co.

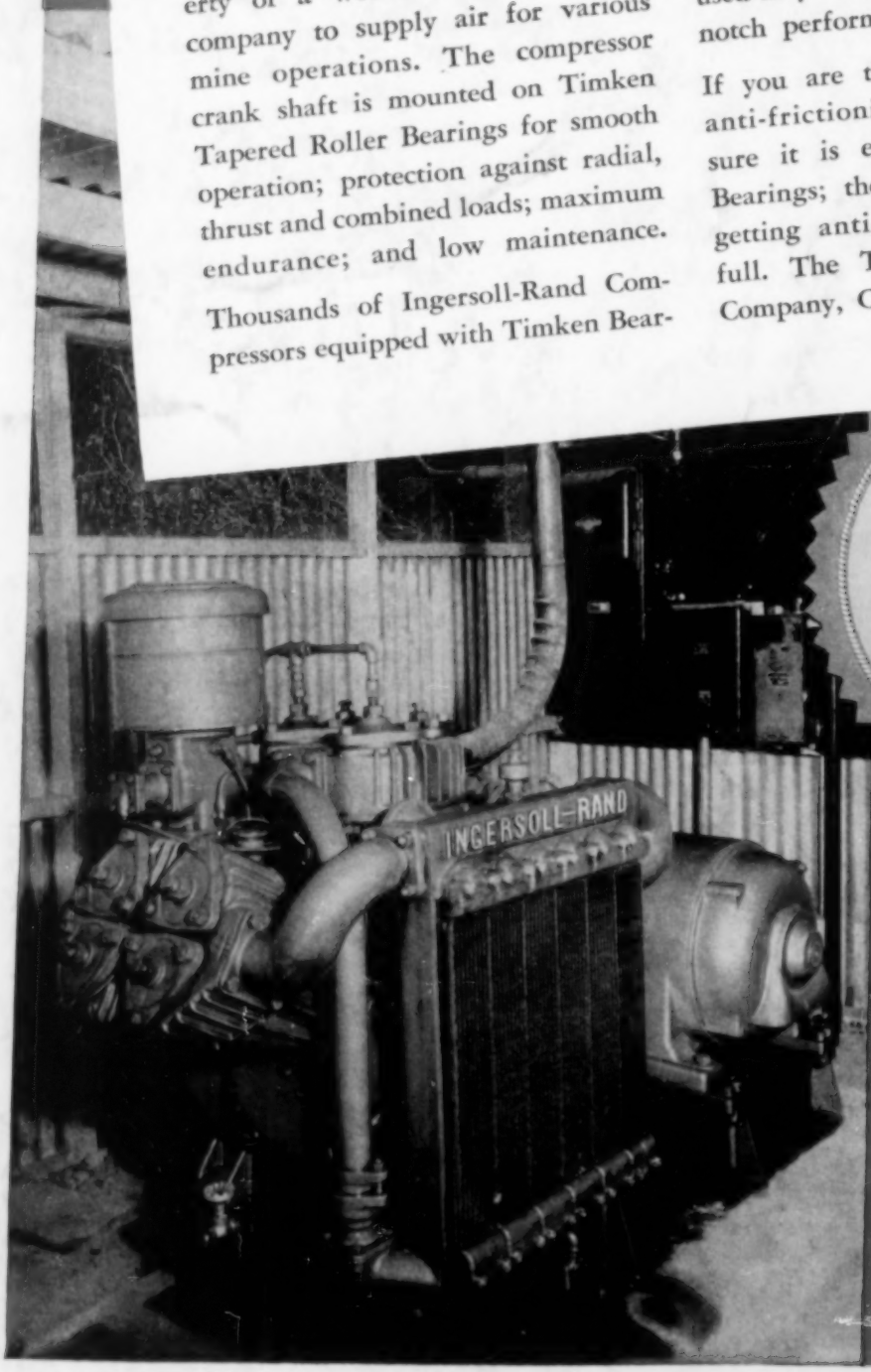
HIGH BRIDGE, NEW JERSEY • EASTON, PENNSYLVANIA

TIMKEN BEARING EQUIPPED COMPRESSOR
Supplies Air For Strategic Metal Mine

This Ingersoll-Rand 50 B Motor Compressor is installed at the property of a well-known quicksilver company to supply air for various mine operations. The compressor crank shaft is mounted on Timken Tapered Roller Bearings for smooth operation; protection against radial, thrust and combined loads; maximum endurance; and low maintenance.

Thousands of Ingersoll-Rand Compressors equipped with Timken Bearings are in service in mines; factories; construction work and other kinds of service. And wherever they are used they are giving dependable, top-notch performance.

If you are thinking of buying an anti-frictionized compressor make sure it is equipped with Timken Bearings; then you will be sure of getting anti-friction advantages in full. The Timken Roller Bearing Company, Canton, Ohio.



Beat post-war competition to the punch; redesign your products to use more Timken Bearings.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS